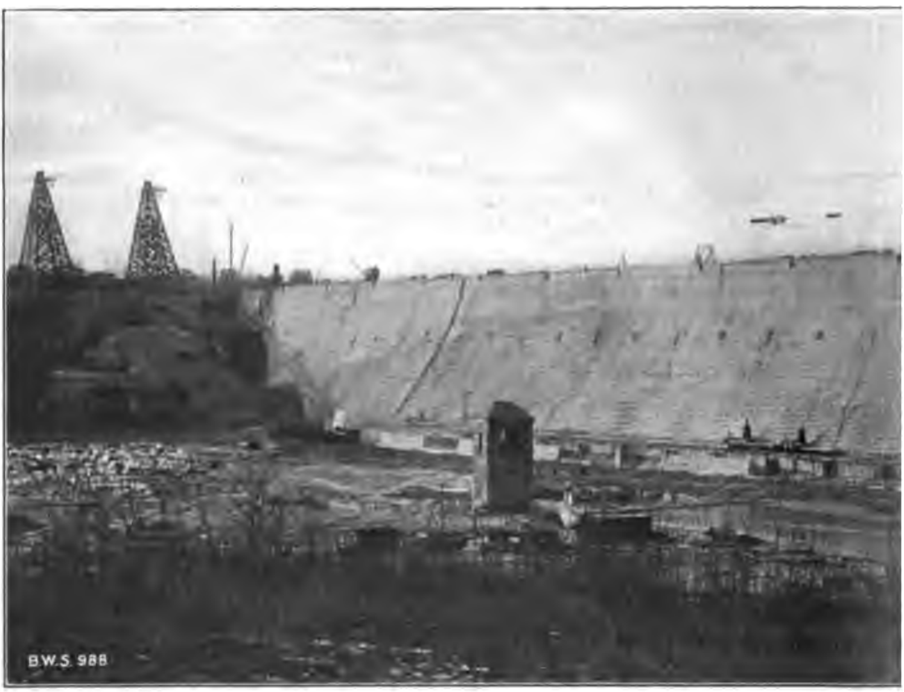
COMPLIMENTS OF THE

BOARD OF WATER SUPPLY

OF THE

CITY OF NEW YORK

MUNICIPAL BUILDING



KENSICO DAM—April 9 and December 23, 1914. Between these dates, a length of 1,388

fet 155 feet high was built completing the dam for
season including 84,450 cubic yards placed

NINTH ANNUAL REPORT

OF THE

Board of Water Supply

OF THE

CITY OF NEW YORK

Accompanied by Report of

THE CHIEF ENGINEER

December 31, 1914

NEW YORK CITY

TABLE OF CONTENTS

ILLUSTRATIONS

BOARD OF WATER SUPPLY
CITY OF NEW YORK

Municipal Building

NEW YORK, December 31, 1914.

HON. JOHN PURROY MITCHEL,
Mayor of The City of New York,
Executive Chamber, City Hall, New York.

SIR:

We submit herewith the report of the Board of Water Supply for the year ending December 31, 1914.

Disbursements and Liabilities

Disbursements during the year for all purposes were about $14,000,000, bringing the total cash amount disbursed for the purposes of the Board since the organization on June 9, 1905, to $123,000,000. The registered liabilities to date are $11,000,000 and the total obligations to date are $134,000,000.

Construction Progress

Fourteen contracts and five agreements, amounting to $2,702,200, were awarded during the year.

The amounts of contracts finished, and now in progress, aggregate $99,000,000, of which $90,000,000 represent work done to date, of which $11,000,000 were done during 1914.

With the award of Contract 99, for the construction of the Narrows siphon, and of Contract 160, for Moodna Siphon supplementary shaft and tunnel, the last links in the 121-mile waterway connecting Ashokan reservoir, in the Catskills, with Silver Lake reservoir, on Staten Island, were placed under contract.

Pending unforeseen requirements, which may be indicated by service tests, this constitutes all construction essential to the delivery of Catskill water from Esopus watershed to the five boroughs of The City.

The entire waterway length, with the exception of the portion of the Moodna tunnel, 900 feet long, just west of the Hudson River crossing, and of the Narrows pipe crossing, 10,570 feet long, is practically ready to convey water; so that the work for the first

instalment of water of 250,000,000 gallons daily is 93 per cent. done, and as closely as may be anticipated this instalment will be ready for delivery in 1916.

Ashokan Reservoir

Olive Bridge dam and the Beaver Kill and Hurley dikes were substantially completed and water has been impounded in the West basin throughout the year. Water drawn from this basin was used at rates up to 469,000,000 gallons per day for the purpose of testing stretches of completed aqueduct. The Dividing weir and its gate-houses were practically finished. The East basin was cleared of timber growth and brush. Highways and fences around the reservoir were well advanced. All nine highway bridges and all wire fences about the reservoir were completed and work on Ashokan bridge over the Dividing weir was well advanced; 30 miles of highway, out of 34 under contract, were surfaced and thrown open to traffic. Six miles remain to be put under contract.

Kensico Reservoir

Placing masonry for Kensico dam exceeded the phenomenal rate established last year and again broke all records for dam construction, having reached 84,450 cubic yards of masonry placed in a month. The record held previous to those made at this dam was established in 1909 at the Olive Bridge dam where 35,300 cubic yards were laid in a similar period. During this season 489,800 cubic yards were laid. At its central and thickest portion a continuous stretch of 1,388 feet is finished, except for the dimension stone on the down-stream face. Of the 872,000 cubic yards of masonry to be placed in the dam, 806,000 cubic yards have been laid. Improvement of the reservoir basin, by removing tree growth below the water-line and by filling various hollows, has actively progressed.

Hill View Reservoir

Excavation for the reservoir and construction of embankment were practically completed. The concrete lining on the side slopes and bottom of the reservoir was about 79 per cent. completed, for the former, and about 88 per cent. for the latter. The work as a whole was about 91 per cent. completed. Hydrostatic test of the West basin of the reservoir was begun toward the end of the year.

Silver Lake Reservoir

Progress on this, the terminal reservoir of the system, in Staten Island, begun late last year, was consistently maintained at the contract requirements. As measured by the monthly estimates, it is 40 per cent. completed.

Catskill Aqueduct

Following completion, various stretches of aqueduct between Ashokan reservoir and the east side of the Hudson river were being tested under working conditions in order to forestall any changes which operation of the water-works might dictate. Among these changes was the construction of a supplementary shaft and tunnel at the eastern end of Moodna siphon.

City Tunnel and Pipe-Lines

All work within the City limits necessary to deliver Catskill water to the five boroughs has been contracted for, and the earnings of the contractors indicate that of this essential work 98 per cent. is done. The lining of the 18-mile tunnel from Hill View reservoir to Brooklyn, which was one-third finished at the beginning of the year, was completed. There remain the construction of some valve chambers, the installation of some of the valves and the performance of acceptance tests.

All pipe-lines in Brooklyn, Queens and Richmond boroughs, with the exception of the Narrows siphon, for the purpose of delivering water from the terminal shafts of the City tunnel, are substantially done and 11 miles out of the 16 miles are being used by the Department of Water Supply, Gas and Electricity for operation in connection with the existing distribution system.

Narrows Siphon

The Narrows crossing is an important link connecting Staten Island with the aqueduct and means relief to that community from its present inadequate and unsatisfactory supply. The work of laying the flexible 36-inch pipe along the harbor bed has been attended by many novel problems requiring exhaustive experiment to obtain satisfactory results. It is to be noted by the hydrostatic tests of 1,000 feet of the portion already laid that the leaded flexible joints are tight and that there is not only an absence of leakage but even of seeping with indications that no submarine calking may be necessary. There are laid 4,500 feet out of 10,570 feet.

Filtration

The public demand for water of a high standard, both in appearance and in purity, was recognized at the inception of the work by making provision for a full-capacity filtration plant in the original plans.

Designs for such a plant were advanced to the point where its location, area and other essential details were determined so as to permit proper provision for its construction in connection with the acquisition of land and the construction of the aqueduct and the distributing reservoirs. Studies were then discontinued to give attention to more pressing work. With the impounding of water commenced at Ashokan reservoir, the subject again came forward from the following considerations:

The Board of Water Supply is neither vested with statutory power adequately to abate nuisances threatening contamination in the watersheds, nor to construct sanitary sewers to care for possible pollution in the most exposed districts. During flood periods, eroded clay, which takes a long time to settle, is brought into the reservoirs in sufficient quantity to discolor the water. As the location of the filters is settled, the necessary land has been acquired, and the necessary aqueduct connections are built, the Chief Engineer was therefore authorized to continue investigations looking to the treatment of Catskill water by filtration and other means of purification.

Schoharie Watershed

On October 21 the application of The City to impound water from Schoharie creek and conduct such supply to The City of New York through the Catskill aqueduct was granted by the State Conservation Commission. A large dam and reservoir will be built at Prattsville and thereby conserve all the water in the upper part of the Schoharie watershed to the extent of 228 square miles. The water will then be led through a tunnel ten miles long into the Esopus creek to be stored in the Ashokan reservoir. The new watershed will add about 200,000,000 gallons per day to the Esopus supply. The estimated cost of this work is $14,216,000 and the time for completion about eight years. About 2,000 acres of land will be acquired including 13 miles of highways. Borings to determine the exact location of the dam and other features are already in progress as a necessary preliminary to land-taking surveys and construction plans.

Legislation

At the last Legislature the Board opposed the Maier bill limiting the jurisdiction by The City of the distribution of Catskill water in Queens county. This bill was vetoed by the Governor.

The important legislation that the Board of Water Supply is interested in for the coming year is the protection of the water that enters the reservoir from pollution, and equitable assessment.

Aqueduct Police

As heretofore, stress is laid on the preventive value of the Board's police force. The mere presence of a body of men of proved personal courage and of general efficiency as a corps has proved a valuable deterrent to those criminally inclined.

Damage Claims

Investigations for the defense of business, wage, indirect real estate and diversion claims were continued and The City's special counsel was assisted in the trial of cases involving these and fee damage cases still undisposed of.

In accordance with the established policy of the Board, claimants were encouraged to settle cases directly with the Board of Water Supply in order to avoid the expense, delay and uncertainty of legal proceedings.

Water-power or diversion claims on account of their importance have necessitated special work and the employment of hydraulic engineering experts.

During the year 1914, 66 claims aggregating $1,826,692 were received, making a total to December 31, 1914, of 939, aggregating $6,083,728.

The business damage commissions had to December 31, 1914, heard 379 business damage cases aggregating an amount claimed of $2,456,660. On these a total of $165,808.51 was awarded. Part of this amount has been paid and the balance is in process of determination.

Rentals Collected

As part of the supervision of houses and real estate owned by The City and under the control of the Board $7,115.03 rents were collected, making a grand total of $78,811.71. On January 1, 1914, there were 161 such houses and on December 31, 75.

Organization

In the conduct of the administration work there has been an effort made at closer co-ordination by redistributing duties and encouraging increased knowledge on the part of each individual of the general work of others.

The Board has consistently reduced its force from time to time, both administrative and engineering, as the work progressed, proportionately in relation to its various phases.

The total force of the Board now consists of 995 employees, a reduction of 195 since the same date last year with a decrease of salaries aggregating about $400,000. The force is divided approximately as follows: Administration 51, which includes the Commissioners and the forces of the Auditor, Bureau of Claims, Examiner of Real Estate, Taxes and Legislation and the Secretary; Police 220 (159 on active duty; 61 unassigned, without pay); Engineering 494; Laborers 230; Total 995.

Respectfully submitted,

CHARLES STRAUSS,
President,
CHARLES N. CHADWICK,
JOHN F. GALVIN,

Commissioners of the Board of Water Supply.

ADMINISTRATION BUREAU

W. Bruce Cobb, *Secretary*

Executive.—The Secretary's office combines the functions of a clearing house and executive center. Through it flows all communications from or to the Commissioners, outside as well as inside the organization. That which emanates from the Board is distributed and sent to its proper destination and that coming to the Board is placed before the several Commissioners unless of a routine nature.

The administrative work for the year began under Joseph P. Morrissey, and was continued under the direction of W. Bruce Cobb, who succeeded Mr. Morrissey as Secretary on February 17, 1914.

In the conduct of the administration work there has been an effort made at closer co-ordination by redistributing duties and encouraging increased knowledge on the part of each individual of the general work of others. In addition there was some saving in methods, notably in simplifying the minutes of Board meetings without detracting from their value and saving at least a day's time in their preparation each week.

FORCE, EXCLUSIVE OF ENGINEERING AND POLICE BUREAUS, 1914

Title	January 1	December 31
Secretary	1	1
Assistant Secretaries	2	1
Auditor	1	1
Chief Clerk	1	1
Examiner, Real Estate and Damages	1	..
Examiner of Real Estate, Taxes and Legislation	..	1
Adjuster of Taxes	1	..
Confidential Secretaries	3	3
Assistant Engineers	2	2
Investigators of Claims	3	3
Bookkeeper	1	1
Clerks	33	22
Stenographers and Typewriters	7	8
Typewriting Copyist	1	..
Messengers	2	2
Laborers	2	2
Totals	61	48

Contracts.—During the year 14 contracts were awarded and executed after approval as to form by the Corporation Counsel. Five agreements, nine leases and many miscellaneous instruments were also executed. There were issued to prospective bidders or others interested 316 pamphlets containing information for bidders,

form of contract and drawings; $3,020 were received on deposit for the return of these. Unredeemed deposits amounting to $295 were turned over to the Auditor for deposit with the Chamberlain to the credit of the fund for additional water-supply.

New rules governing the return and forfeiture of deposits and vesting a reasonable discretion in the Secretary were put into effect.

Annual Reports.—During the year the mailing lists maintained respectively by the Administration and Engineering bureaus were consolidated, revised, and extended in response to an increased demand from public libraries and educational institutions. The larger educational institutions and public libraries were all included. Their appreciation is made evident by repeated demands for past reports and Board publications to complete their files. The small pamphlet giving a general description of the Board's work and progress proved popular and by request of the New York Public Library was distributed to all its branches.

Automobile Daily Report Cards.—Automobile daily report cards for all automobiles signed by the chauffeur driving each individual car and countersigned by the person responsible for the use of the car were required as heretofore. Under a new system, records therefrom were kept with greater particularity and method, so that not only is there a daily chronicle of each car with respect to mileage, oil and gasoline consumption, but its monthly record and totals, together with entire total mileage can be seen at a glance, as well as the average mileage and gasoline consumption per day for a given month. In addition there is a controlling record showing the monthly performance of each car with yearly totals, not only for each car, but for all cars.

In the office of the Chief Clerk of the Administration bureau careful record of the tires is kept. As a result, check is not only possible on the use of the cars, but valuable data is presented to aid in determining cost of running and maintenance.

Fire Protection.—Under direction of the Board and by co-operation with the Fire Department, rules were formulated and fire squads established for the purpose of fire protection to the Board's employees in the Municipal Building.

Supplies and Payrolls.—The work of the Chief Clerk, Administration bureau, continued under the direction of Joseph M. S. Millette, who was succeeded on July 9, 1914, by William Haupt.

The methods of purchase of supplies and incurring other ex-

penses under $1,000 were carefully studied and revised and resolutions passed by the Board re-defining the practice, and reiterating the policy of the Board in favor of competitive bidding wherever desirable or profitable. In every case where competitive bidding is dispensed with a satisfactory statement or certificate specifically giving the reasons therefor is required of the official making the recommendation.

The contingent expense fund was transferred from the Chief Clerk, Administration bureau, to the Auditor, who was bonded therefor, instead of the Secretary, whose control heretofore in the handling of the fund was indirect and remote.

As heretofore, all bills on open-market purchases were examined, checked and certified for payment. The Chief Clerk also maintained a central system of records and files of all purchases with unit prices; records of automobile tires, including mileage, examinations, adjustments and replacements; civil service records of appointments and separations affecting the entire Board and payroll records. Payrolls of the Administration and Police bureaus were prepared and salary checks written for the entire force.

During 1914 there were received 1,018 requisitions, and 2,627 orders were issued, aggregating an expenditure of $129,240.07.

REAL ESTATE, TAXES AND LEGISLATION

A. F. Britton, *Examiner of Real Estate, Taxes and Legislation*

The Bureau of Real Estate and Damages and the Bureau of Taxes and Assessments were consolidated in March, 1914, and A. F. Britton was placed in charge of the consolidated bureau with the title of Examiner of Real Estate, Taxes and Legislation.

Houses.—On January 1, 1914, there were in the Reservoir, Northern, Southern and City Aqueduct departments 161 houses occupied by tenants, and on December 31, 1914, there were 75 houses, of which 39 are in the Reservoir department, 5 in the Northern Aqueduct department, 23 in the Southern Aqueduct department, and 8 in the City Aqueduct department; the difference in number being due to the fact that houses were turned over to the contractors for destruction or were destroyed by the Board's forces because of the necessities of the work.

Legislation.—Copies of the 1,681 Senate bills and 1,834 Assembly bills introduced into the Legislature during the year 1914 were received promptly and were carefully scrutinized and noted so far as affecting the work of the Board.

Taxes.—In August, 1914, the assessed valuations of all the property acquired by the Board of Water Supply for The City of New York were obtained. This necessitated visiting the chairman of the board of assessors in each of 20 towns in Westchester, Orange, Ulster and Putnam counties, and examining the tax-rolls to see if the assessed valuations for the year 1914 were the same as for the year 1913, and to see that no unjust discrimination against The City had been made.

Early in November, 1914, bills for school taxes in the various school districts in the several counties in which the Board of Water Supply has acquired property for The City were received and compared with the lists of previous years. Vouchers were prepared, and payments were made to the school collectors. These payments aggregated $8,659.01.

Testimony.—All testimony taken before the commissioners of appraisal, both of fee and business damages, was carefully read and indexed in this office, and almost daily recourse was had to these volumes by the Real Estate Engineer and others of the employees of the Board.

Abstracts of Title.—All abstracts of title to the lands acquired by The City for the Catskill Water Supply are filed in this bureau, and constant reference is made to them, not only by the Board of Water Supply employees, but by the Department of Finance and the Corporation Counsel's office.

A large amount of correspondence is conducted by this office on the subject of real estate, including the houses occupied by tenants of the Board. Agreements, leases and various other papers were prepared by the Examiner, or were submitted to him for examination and their execution procured.

POLICE BUREAU

GEORGE F. SHRADY, *Superintendent of Police*

FORCE IN POLICE BUREAU IN 1914

Title	January 1, 1914	Appointed	Separated	December 31, 1914	
				On Leave Without pay	On Active Duty
Superintendent	1	...	...	...	1
Inspector	1	...	1	...	...
Veterinarian	1	...	...	...	1
Headquarters Sergeant	...	1	...	...	1
Automobile Engineman	1	...	...	...	1
Sergeants	72	...	20	20	32
Patrolmen	206	...	55	41	110
Stenographer	1	...	...	...	1
Typewriting Copyist	1	...	...	...	1
Caretakers	19	4	12	...	11
Clerk	1	...	1	...	...
Totals	304	5	89	61	159

On January 31, because of progress of construction work, the following precincts were closed: Elmsford, Pleasantville, Millwood, Yorktown Heights, Peekskill, Garrison, Cold Spring, Cornwall, East Coldenham, Gardiner and New Paltz.

The closing of the above precincts necessitated the laying off without pay of 34 sergeants and 73 patrolmen.

At the date of this report police precincts are being maintained at West Shokan, West Hurley, Kensico, Valhalla and Yonkers; and sub-precincts, or detachments, at Ashokan, Brown's Station, New Paltz, Storm King, Cornwall, Peekskill and Elmsford, the men being thus distributed throughout the area of activity of the contractors' forces along the line of the work on both sides of the Hudson river from the Ashokan reservoir to the City line at Yonkers.

During the year 31 police officers were transferred, under the special act of Legislature, to the Police department of The City of New York as patrolmen. In addition, 19 men were transferred to the Department of Correction as prison keepers, and 12 resigned to accept other positions. One inspector and nine patrolmen were dismissed on charges.

ARRESTS AND CONVICTIONS DURING 1914

	Arrested	Convicted	Cases Pending
Misdemeanors	281	246	2
Felonies	31	21	7
Totals	*312	**267	9

*Includes 147 contractors' employees
**Includes 128 contractors' employees

Amount of fines collected	$1,105.15
Court costs	18.55
Amount of bail forfeited	200.00

Many of the arrests made were for serious offenses, that is, for assault in the first degree, robbery, etc., and on the night of June 22, at the request of the Sheriff of Westchester county, a squad of mounted men of the force, called in as peace officers, assisted in suppressing a riot at Tarrytown-on-Hudson.

A total of about 233 tons of hay on City property was cut on shares, whereof The City received one-half to feed the Board's police horses and the contractor the other half for his work.

BUREAU OF CLAIMS

WALTER LEC. BOYER, *Chief of Bureau*
JOHN H. MCMANUS, *Acting Chief of Bureau*

The claims referred to this bureau are those for damage to established business (business claims); for decrease in value of real estate not taken (indirect real estate claims); for loss of employment in established business or upon lands taken (wage claims); and for damage by reason of the diversion of the water of streams (diversion claims). The offices of the bureau were continued at Kingston.

The following table shows that 66 claims were filed during the year, amounting to $1,826,692. The total number of claims and the aggregate amount thereof, so far as stated, are also shown. Many claims filed do not specify amounts.

CLAIMS FILED TO DECEMBER 31, 1914

CLASS	December 31, 1913		Received During 1914		Total on December 31, 1914	
	Number	Amount	Number	Amount	Number	Amount
Business	641	$3,193,054.00	25	$182,800.00	666	$3,375,854.00
Indirect real estate.	144	625,350.00	31	108,950.00	175	734,300.00
Wage	86	23,632.00	4	942.00	90	24,574.00
Diversion	2	415,000.00	6	1,534,000.00	8	1,949,000.00
Totals	873	$4,257,036.00	66	$1,826,692.00	939	$6,083,728.00

There are records in the bureau of 1,124 claims. Only 939 of these, however, are for matters coming under the jurisdiction of the bureau, the remainder being for survey damage and other matters otherwise disposed of by the Board

These claims were recorded, individual claims investigated and reports on same furnished from time to time to the Board and the Corporation Counsel.

In addition to investigations of individual claims, studies were continued during the year, maps and charts made and data prepared, covering general conditions in the territory affected by the Board's operations, viz.: New building activity, migration of inhabitants, property values and title transfers, census of businesses in the proposed watersheds, the stone and lumber industries, groundwater distribution and water-power development, traction and railroad facilities, general farm conditions, etc., and the material thus collected has been placed at the disposal of the Corporation Counsel's representatives in their preparation for the defense of claims. A hydraulic-engineering expert was assigned to assist in the special

work of preparing to meet large water-power, or diversion claims. In preparation of the defense against large quarry claims which will soon come to trial, special studies and records of various quarries were made.

Assistance was rendered The City's special counsel not only in the trial of claims coming under the above classifications, but also in the defense of railroad and other fee cases still undisposed of, and in certiorari proceedings to review the tax assessments on City property in the towns of Gardiner and Shawangunk.

Representatives of the bureau were used from time to time as witnesses in the trial of cases before the commissions. Records of all the proceedings before the commissions were taken, and detailed reports as to the status of all claims taken up were forwarded to the Board following each session.

Due to the thorough preparation for defense, the awards have been minimized, and the aggregate amount, in dollars, of the claims dismissed during the year is largely in excess of that of last year.

CLAIMS TRIED BEFORE COMMISSIONS

Disposition	Dates	Number	Amount Claimed: Before Board of Water Supply	Amount Claimed: At Trial	Awards
Awarded	To December 31, 1913	184	$877,440.00	$626,175.00	$123,714.83
Awarded	During 1914	53	465,500.00	340,000.00	42,093.68
Total to December 31, 1914		237	**1,342,940.00**	**966,175.00**	***165,808.51**
Claims dismissed	To December 31, 1913	51	132,300.00	107,300.00	....
Claims dismissed	During 1914	34	195,620.00	189,650.00	....
Total to December 31, 1914		85	**327,920.00**	****296,950.00**	....
Claims withdrawn	To December 31, 1913	21	55,500.00	55,500.00	....
Claims withdrawn	During 1914	9	14,700.00	14,700.00	....
Total to December 31, 1914		30	**70,200.00**	*****70,200.00**	....
Claims pending	December 31, 1914	27	**715,600.00**	**721,600.00**	....
Grand totals		379	**$2,456,660.00**	**$2,054,925.00**	**$165,808.51**

* Appeals, exceptions, modifications, etc., reduce actual awards uncontested to $124,309.85

** Appeals, exceptions, retrials, etc., reduce amount before Board of Water Supply to $323,700 and amount at trial to $290,450

*** Retrials reduce amount to $60,700

The above table excludes one mistrial; case not completed when the commission's time expired

Business Damage Commission 1 ceased operations during the year, its time having expired.

A new commission, known as Railroad Commission 5, was appointed to try the fee of all that portion of real estate formerly occupied by the Ulster and Delaware railroad situated in the towns of Olive and Hurley. Subsequently there were assigned to this commission the trial of several remaining fee parcels, and also a business claim.

Claimants were encouraged to settle directly with the Board, in order to avoid the expense, delay and uncertainty of legal proceedings.

The following claims were settled by direct agreement:

Claim	Name	Amount Claimed	Amount Allowed
1102	Mathews & North	$40,000.00	$20,000.00
1115	Olive Telephone Company	5,000.00	3,000.00

Approval of the Olive Telephone Company settlement is now pending before the Board of Estimate and Apportionment.

The Board's offer for settlement of claim of $50,000 filed by Z. P. Boice for alleged damage to sawmill business was rejected, and negotiations for settlement of other claims amounting to some $92,000 are still pending.

REPORT OF THE AUDITOR

NEW YORK, December 31, 1914.

BOARD OF WATER SUPPLY,
Municipal Building, New York.

GENTLEMEN:

There is transmitted herewith the annual report covering the financial operations of the Board of Water Supply for the year 1914 and for the period from June 9, 1905, to date, composed of an index sheet, three tables, and 47 statements.

Table 1 is a summary of the financial condition of the Board of Water Supply at the close of business December 31, 1914, disclosing:

(a) Total resources.
(b) Total disbursements.
(c) Total known liabilities.
(d) Marginal reserve for further operations as at December 31, 1914.

Table 2 is a complete résumé of the activities of the Board for the period under review, so displayed that the amount and general purpose of the outlays are clearly shown, affording also an opportunity to judge the cost of progressing the work from the percentages given for the year and total to date in the several departments on the line of work.

Assuming that the work of the Board is covered by a single contract, the actual disbursements from June 9, 1905, to date, as per Table 2, for actual construction and supervision thereof is as follows:

DISBURSEMENTS FROM JUNE 9, 1905 TO DECEMBER 31, 1914

	1914	PER CENT.	TOTAL TO DATE	PER CENT.
ACTUAL CONSTRUCTION, ETC.				
Contracts	$11,679,493.63	82.790	$86,470,125.58	70.295
Acquisition of land	728,754.83	05.166	16,802,343.95	13.659
Agreements	8,663.00	00.061	3,552,145.78	02.889
Damages to land	350.00	00.002	7,825.92	00.006
Taxes	30,081.84	00.213	267,250.06	00.217
Total construction	**12,447,343.30**	**88.232**	**107,099,691.29**	**87.066**

	1914	Per Cent.	Total to Date	Per Cent.
SUPERVISION OF CONSTRUCTION, ETC.				
Salaries	$1,416,004.78	10.037	$12,925,231.31	10.507
Equipment	24,089.51	00.171	558,171.32	00.454
Consumable supplies	220,058.00	01.560	2,427,363.70	01.973
Total supervision	**1,660,152.29**	**11.768**	**15,910,766.33**	**12.934**
Total supervision and construction	**$14,107,495.59**	**100.000**	**$123,010,457.62**	**100.000**

Reference is also made on said Table 2 to supporting statements from which the items appearing on this table may be verified and further analyzed in such detail as may be desired.

In Table 3 the disbursements from 1905 to 1914, inclusive, have been arrayed in comparative form by bureaus. The work of the Engineering bureau, it will be noted, has been divided to show the energies devoted to preliminary work of surveys, maps, plans, etc., as distinguished from actual construction. The percentage of disbursements for the several purposes indicated in each year is likewise furnished, thereby affording an opportunity to judge the progress made in the various stages of the work from year to year, i. e., the practical completion of preliminary surveys, etc., and the beginning of actual construction, together with the attendant outlay for administrative and police purposes.

The increase each year in payments to contractors, as disclosed in Table 3, indicates the manner in which the work has been expedited: For example, in 1912 the outlay for said purpose reached high-water mark, the payments in said year for contract work with the amounts and attendant percentages for other purposes being as follows:

DISBURSEMENTS FOR THE YEAR 1912

	Disbursements 1912	Per Cent. of Total
ACTUAL CONSTRUCTION, ETC.		
Contracts	$18,502,180.78	78.451
Acquisition of land	1,941,625.96	08.233
Agreements	700,000.00	02.968
Damages to land	*3,330.30	*00.014
Taxes	43,791.74	00.186
Total construction	**21,184,268.18**	**89.824**
SUPERVISION OF CONSTRUCTION, ETC.		
Salaries	2,043,684.62	08.665
Equipment	40,042.81	00.170
Consumable supplies	315,980.49	01.341
Total supervision	**2,399,707.92**	**10.176**
Total construction and supervision	**$23,583,976.10**	**100.000**

*Credit

DISBURSEMENTS DURING 1913 AND 1914

	1913		1914	
	Amount	Per Cent.	Amount	Per Cent.
Contracts	$16,161,846.32	75.69	$11,712,145.50	83.02
Open-market orders	135,536.84	00.63	114,194.35	00.81
Miscellaneous—acquisition of property, agreements, etc.	3,031,642.61	14.20	715,075.13	05.07
Payrolls	2,023,396.10	09.48	1,566,080.61	11.10
Totals	$21,352,421.87	100.00	$14,107,495.59	100.00

The last column on Table 3 shows the total outlay to date for all purposes; the percentages supplied afford an opportunity to judge the cost of conducting operations in the various bureaus, and the relative proportion which the outlays for the several purposes indicated bear to the total disbursements for the period under review.

Table 3 when studied in connection with Table 2, will be found to present a complete picture of the Board's activities from 1905 to date, and the supporting statements referred to on Tables 2 and 3 supply the means of ascertaining the cost of progressing the work along functional lines in each of the several departments and divisions in detail.

Statements 1, 1-A and 2 cover the outlay for Administration, Police and Engineering purposes and are briefly described as follows:

Statement 1, Classified disbursements for administrative purposes.

Statement 1-A, Classified disbursements for policing the work by precincts.

Statement 2, Composite statement of disbursements for engineering purposes under the broad classification of:

(1) Surveys, maps, plans, etc.

(2) Acquisition of land.

(3) Actual construction.

Statement 2 also refers to supporting statements from which the details of the outlay for the several departments and divisions may be readily ascertained.

Statement A is a recapitulation of the amounts disbursed for acquisition of land and indirect damages pursuant to condemnation proceedings, classified under 21 accounts. Percentages are also supplied to show the proportion which the amounts disbursed for the several purposes indicated bear to the total and also to the amounts paid for awards.

Statement B shows the acreage of land to be taken in each department for construction purposes, the outlay for acreage confirmed and paid, and the average price and expense per acre to date, etc. It will be observed from this statement that the acreage still to be acquired is approximately only 345 acres, of which the total acreage in the Ashokan reservoir is now being tried and the remaining acreage is in a state of litigation.

Statement C shows the outlay to date, classified in detail, for acquisition of land pursuant to condemnation proceedings and private purchase and the outlay for indirect damages in the several departments and sections from Ulster county to Staten Island.

Statements D and E set forth the actual result in 17 closed proceedings in the Reservoir and Northern Aqueduct departments, i. e., sections in which all awards and expenses have been paid.

Deductions aggregating $9,146.14 have been made to date from various bills and vouchers submitted for payment as follows:

1.	Bills approved by the Corporation Counsel and taxed by the Supreme Court for expenses in connection with acquisition of land, etc.	$5,669.20
2.	Advertising	1,864.30
3.	Open-market orders	267.54
4.	Miscellaneous bills	1,345.10
	Total	$9,146.14

Monthly reports as required in Section 36 of Chapter 724, Laws of 1905, also various miscellaneous reports and statements, have been regularly prepared and transmitted to the Comptroller and to the City Record for publication. Quarterly reports covering the activities of the work in condensed form have been regularly submitted to the Board and to the Engineering bureau for distribution in the field, promptly at the end of each quarter.

The work of the office has been extended during the year, at the request of the Corporation Counsel and with the consent of the Board, to the examination of books of various claimants for loss of business alleged to have been caused by the operations of the Board.

Respectfully submitted,

H. C. BUNCKE,

Auditor

REPORT AND FINANCIAL STATEMENT OF THE BOARD OF WATER SUPPLY

Disbursements for the Year and Total Disbursements from June 9, 1905 to Date (Classified by Bureaus, Departments, Divisions and Subdivisions of Work, etc.) and Estimated Liabilities at this Date, December 31, 1914

TABLE 1

Summary of the Financial Condition at the Close of Business, December 31, 1914

RESOURCES

Amount of corporate stock authorized to be issued, pursuant to Section 33 of Chapter 724, Laws of 1905, in accordance with the resolutions adopted by the Board of Estimate and Apportionment from June 16, 1905 to June 26, 1913, as follows:

Date of Resolution	Amount Authorized		
June 16, 1905	$100,000.00		
November 24, 1905	500,000.00		
December 8, 1905	1,002,000.00		
November 23, 1906	10,000,000.00		
June 14, 1907	15,000,000.00		
March 20, 1908	11,000,000.00		
June 26, 1908	22,600,000.00		
February 26, 1909	41,200,000.00		
July 1, 1910	25,000,000.00		
March 6, 1913	14,715,000.00		
June 26, 1913	755,000.00		
		$141,872,000.00	
Premium on sale of corporate stock		539,322.97	
Miscellaneous revenue		104,526.10	
Total resources			$142,515,849.07

DISBURSEMENTS AND LIABILITIES

Disbursements

		Year 1914	Total to Date	
Per Statement 1	Administration bureau	$123,121.35	$1,313,419.57	
Per Statement 1-A	Police bureau	232,667.42	1,995,050.28	
Per Statement 2	Engineering bureau	13,751,706.82	119,701,987.77	
Total disbursements		$14,107,495.59		$123,010,457.62

Liabilities

CONTRACTS—			
A. Registered after public letting, as per Statement 6	$10,468,346.30		
B. Agreements—informal, as per Statement 6	391,934.53		
Open market orders, as per order register	38,696.47		
Acquisition of property, as per register	7,863.58		
Miscellaneous—agreements, as per register	6,815.00		
All other miscellaneous, as per register	11,451.67		
Total liabilities		$10,925,107.55	
Total disbursements and liabilities			$133,935,565.17
January 1, 1915, amount available, i. e., excess of bond authorization over disbursements and liabilities			$8,580,283.90

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	For Details see Statements	Salaries			P
		1914	Per Cent.	Total to Date	
ADMINISTRATION BUREAU....	1	$114,556.53	00.812	$1,081,837.29	
POLICE BUREAU................	1-A	201,826.17	01.431	1,652,679.41	
ENGINEERING BUREAU					
HEADQUARTERS DEPARTMENT					
Surveys, maps, plans, etc..	7	....	......	1,206,841.74	
Permanent construction...	14	340,478.52	02.413	1,451,415.29	
RESERVOIR DEPARTMENT					
Surveys, maps, plans, etc..	8	....	......	317,334.70	
Permanent construction...	15	157,243.10	01.115	896,801.78	
NORTHERN AQUEDUCT DEPARTMENT					
Surveys, maps, plans, etc..	9	....	......	993,116.93	
Permanent construction...	16	94,366.03	00.669	1,820,166.79	
SOUTHERN AQUEDUCT DEPARTMENT					
Surveys, maps, plans, etc..	10	414.36	00.003	308,939.47	
Permanent construction...	17	225,618.40	01.599	1,668,146.65	
CITY AQUEDUCT DEPARTMENT					
Surveys, maps, plans, etc..	7	2,098.73	00.015	179,169.67	
Permanent construction...	18	268,758.22	01.905	904,160.84	
LONG ISLAND DEPARTMENT					
Surveys, maps, plans, etc..	11	*236.53	*00.002	196,391.16	
RONDOUT SUPPLY					
Surveys, maps, plans, etc......	12	5,868.76	00.042	42,538.57	
SCHOHARIE SUPPLY					
Surveys, maps, plans, etc......	12	3,722.22	00.026	23,606.39	
**CATSKILL SUPPLY					
Surveys, maps, plans, etc......	12	1,290.27	00.009	9,546.45	
PRELIMINARY EXPENSES......	13	....	......	222,538.18	
Totals	....	$1,416,004.78	......	$12,925,231.31	
PERCENTAGE OF TOTAL FOR 1914	....	....	10.037	....	
PERCENTAGE OF TOTAL TO DATE	....	....	......	....	

The amount expended for acquisition of land includes salaries of the Engineering from June 9, 1905 of $290,898.20 not included in the salaries column of this table. U ments for acquisition of land the disbursements for ees of special counsel and commission in Statement 4

	For Details See Statements	1905 Amount	1905 Per Cent.	1906 Amount	1906 Per Cent.
ADMINISTRATION	1				
Salaries	....	$27,891.12	23.576	$65,719.10	07.554
Equipment	....	3,073.50	02.598	1,978.76	00.227
Consumable supplies and expenses	....	2,578.64	02.179	16,760.24	01.926
Bureau totals......	....	33,543.26	28.353	84,458.10	09.707
POLICE	1-A				
Salaries	....	....	......	....	......
Equipment	....	....	......	....	......
Consumable supplies and expenses	....	....	......	....	......
Bureau totals......	....	....	......	....	......
ENGINEERING					
SURVEYS, MAPS, PLANS, ETC.	3				
Salaries	....	45,027.19	38.060	416,890.27	47.912
Equipment	....	12,083.87	10.214	79,368.17	09.122
Consumable supplies and expenses	....	27,651.16	23.373	162,732.26	18.702
Contracts	....	....	......	14,610.88	01.679
Agreements	....	....	......	92,204.26	10.597
Damages to land..........	....	....	......	937.38	00.107
Totals	....	84,763.22	71.647	766,742.73	88.119
ACQUISITION OF PROPERTY...	4	....	......	18,913.38	02.174
PERMANENT CONSTRUCTION..	5				
Salaries	....	....	......	....	......
Equipment	....	....	......	....	......
Consumable supplies and expenses	....	....	......	....	......
Taxes	....	....	......	....	......
Contracts	....	....	......	....	......
Agreements	....	....	......	....	......
Damages to land..........	....	....	......	....	......
Totals	....	....	......	....	......
Bureau totals......	....	84,763.22	71.647	785,656.10	90.293
Grand totals	....	$118,306.48	100.00	$870,114.20	100.00

FROM 1905 TO 19

1907		
t	Per Cent.	An
.10	08.811	
.07	00.123	
.59	01.063	
.06	04.997	
.....	......	
.....	......	
.....	......	
.....	......	
.28	35.261	
.59	05.205	
.72	08.150	
.33	02.735	
.92	18.495	
.50	00.143	
.34	60.960	
.34	16.818	1
.93	01.402	
.08	00.050	
84.34	00.563	
.....	......	
.28	06.133	1
.00	00.048	
.....	......	
.23	08.196	1
.41	95.003	4
.57	100.00	84

STATEMENT 1

Classified Disbursements of Administration Bureau

	1914	Total to Date
SALARIES		
Commissioners	$36,000.00	$342,598.60
Secretaries to Commissioners	6,325.00	53,948.09
Secretary's office	23,122.51	191,031.63
Auditor's office	22,932.15	162,580.39
Chief Clerk's office	16,007.22	163,306.12
Examiner of Real Estate, Taxes and Legislation's office	4,905.25	72,919.12
Messengers, cleaners, etc.	4,300.00	32,410.27
Garage	704.72	4,622.73
Stenographic services, State Board hearings	259.68	8,420.34
EQUIPMENT		
Furniture and fixtures	353.89	19,135.86
Transportation equipment	....	14,525.00
CONSUMABLE SUPPLIES AND EXPENSES		
Stationery and printing	4,734.19	61,819.66
Traveling expenses	515.68	18,178.27
Postage, telegrams, telephone and messenger service	2,027.05	17,397.22
Miscellaneous expenses	1,518.89	26,539.51
Rent of offices	....	92,101.06
Advertising	....	2,922.30
Contingent fund	*2,500.00	5,000.00
Auto hire	....	3,686.45
Repairs and maintenance of automobiles	1,300.97	12,953.86
Advertising State Board hearings	603.05	7,171.66
All other expenses, State Board hearings	11.10	151.43
Totals	$123,121.35	$1,313,419.57

* Credit caused by deduction of contingent fund

STATEMENT 1-A

Disbursements of Police Bureau by Precincts

	Salaries		Equipment		Consumable Supplies and Expenses		Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
Headquarters	$17,920.85	$108,024.63	*$7,054.56	$82,395.41	$2,376.33	$37,076.85	$13,242.62	$227,496.89
Inspector's office	801.56	24,950.29	*1,718.53	801.91	33.88	7,772.56	*883.09	33,524.76
Instruction squad	....	39,895.51	938.07	3,738.32	125.35	9,922.98	1,063.42	53,556.81
Olive Bridge—West Shokan precinct	27,220.69	124,409.37	912.27	5,887.65	4,572.40	18,073.13	32,705.36	148,370.15
Brown's Station detachment	6,413.08	6,413.08	181.51	181.51	1,414.61	1,414.61	8,009.20	8,009.20
Ashokan detachment	7,137.43	7,137.43	109.08	109.08	935.17	935.17	8,181.68	8,181.68
Stone Ridge precinct	....	32,942.51	407.47	1,162.47	86.31	4,866.61	493.78	38,971.59
High Falls precinct	....	35,438.17	620.47	1,180.19	85.03	5,260.48	705.50	41,878.84
Mohonk precinct	....	17,811.31	33.13	117.02	50.01	1,796.37	83.14	19,724.70
New Paltz precinct	6,354.22	73,692.89	590.00	1,800.25	1,736.11	11,841.52	8,680.33	87,334.66
New Hurley precinct	....	26,180.89	419.73	949.32	54.15	3,354.87	473.88	30,485.08
West Hurley precinct	19,367.98	72,213.03	502.99	801.48	3,117.06	9,133.42	22,988.03	82,147.93
East Coldenham precinct	1,121.49	40,492.51	105.08	541.71	592.87	7,499.73	1,819.44	48,533.95
Gardiner precinct	1,069.24	41,176.62	196.29	331.13	384.85	5,346.36	1,650.38	46,854.11
Cornwall precinct	1,511.05	81,905.21	439.17	2,243.50	498.24	11,490.03	2,448.46	95,638.74
Nelsonville—Cold Spring precinct	8,300.14	82,184.91	381.32	889.46	1,702.23	7,342.56	10,383.69	90,416.93
Garrison precinct	6,042.62	84,873.68	410.92	1,233.44	1,484.39	7,718.86	7,937.93	93,825.98
Sprout Brook precinct	....	45,812.29	208.26	567.01	120.50	5,808.50	328.76	52,187.80
Peekskill precinct	2,730.34	92,594.98	366.09	2,337.08	552.37	9,730.44	3,648.80	104,662.50
Yorktown Heights precinct	1,503.21	72,742.18	313.17	821.28	642.24	8,657.32	2,458.62	82,220.78
Kitchawan—Millwood precinct	881.86	60,241.03	178.35	826.44	321.81	5,897.32	1,382.02	66,964.79
Pleasantville precinct	2,393.05	81,327.14	140.10	820.08	498.56	6,497.04	3,031.71	88,644.26
Valhalla precinct	27,989.49	119,938.50	492.26	980.70	2,003.22	7,559.16	30,484.97	128,478.36
Kensico precinct	27,678.36	84,879.51	884.04	3,435.04	4,564.98	17,080.98	33,127.38	105,395.53
Elmsford precinct	7,624.34	93,295.39	212.07	1,396.11	1,461.65	8,548.22	9,298.06	103,239.72
Yonkers precinct	27,765.17	102,106.35	366.52	856.60	791.66	5,341.59	28,923.35	108,304.54
Totals	**$201,826.17**	**$1,652,679.41**	**$635.27**	**$116,404.19**	**$30,205.98**	**$225,966.68**	**$232,667.42**	**$1,995,050.28**

* Credits caused by adjustment of storeroom

	Headquarters		Inspector[s]
	1914	Total to Date	1914
SALARIES	$17,920.85	$108,024.63	$801.56
EQUIPMENT			
Furniture and fixtures	226.60	1,440.41	....
Horses	....	58,712.50	....
Harness	*4,972.24	80.78	*1,195.75
Other equipment	*8,929.72	14,477.74	*522.78
Offices and buildings	....	....	....
Storeroom account	6,620.80	7,683.98	....
CONSUMABLE SUPPLIES AND EXPENSES			
Ammunition	*70.62	8.90	*5.88
Forage	440.25	3,199.51	....
Horse-shoeing	18.00	57.15	....
Boarding horses	....	366.25	....
Veterinary expenses	*24.74	65.59	*132.03
Other stable expenses	*557.34	19.57	*308.67
Repairs and renewals	*170.09	855.14	*339.14
Repairs and maintenance of buildings	....	16.30	....
Stationery and printing	*1,595.55	1,653.47	*354.55
Telephone service	548.48	3,185.31	73.61
Fuel and light	....	470.47	....
Team hire	2.00	114.50	....
Traveling expenses	1,067.75	8,394.88	138.57
Rentals, offices and buildings	....	1,100.00	....
Miscellaneous expenses	710.01	4,009.46	*9.04
Repairs and maintenance of automobiles	2,008.18	11,803.26	971.01
Advertising	....	1,465.00	....
Expenses of municipalities in criminal actions	....	292.11	....
Totals	$13,242.62	$327,496.89	*[illegible]

	Cornwall[is]
	1914
SALARIES	$1,511.05
EQUIPMENT	
Furniture and fixtures	....
Horses	....
Harness	298.28
Other equipment	140.89
Offices and buildings	....
Storeroom account	....
CONSUMABLE SUPPLIES AND EXPENSES	
Ammunition	3.99
Forage	146.85
Horse-shoeing	48.50
Boarding horses	....
Veterinary expenses	6.69
Other stable expenses	58.62
Repairs and renewals	18.53
Repairs and maintenance of buildings	....
Stationery and printing	79.98
Telephone service	5.95
Fuel and light	21.98
Team hire	12.00
Traveling expenses	8.84
Rentals, offices and buildings	40.00
Miscellaneous expenses	46.33
Repairs and maintenance of automobiles	....
Advertising	....
Expenses of municipalities in criminal actions	....
Totals	$2,448.46

* Credits caused by adjustment of storeroom

...ce	Instruct...
...ate	1914
50.29	....
51.30	....
.....	....
35.00	$943.20
15.61	*5.13
.....	....
.....	....
.....	2.85
.....	....
.....	....
.....	....
.....	....
.....	76.74
81.94	9.00
87.95	....
80.90	36.76
56.69	....
28.30	....
.....	....
10.49	....
31.00	....
23.97	....
01.32	....
.....	....
.....	....
84.76	$1,063.42

...ict	Nelso... Cold Spri...
...Date	1914
5.21	$8,300.14
3.99	....
.....	....
7.78	169.91
9.73	211.41
7.00	....
.....	....
3.99	4.56
4.70	793.57
7.25	115.70
9.50	....
8.05	12.41
8.10	21.15
0.95	25.75
5.72	....
8.58	79.10
9.95	70.50
0.47	166.75
7.40	....
8.12	42.28
0.00	330.00
9.25	40.46
.....	....
.....	....
.....	....
8.74	$10,383.69

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DISBURSEMENTS OF ENGINEERING

FOR MAIN CLASSIFICATION SEE	STATEMENT 3			S
	For Detailed Classification see Statements	Surveys, Maps, Plans, etc. 1914	Surveys, Maps, Plans, etc. Total to Date	Acqu 19
HEADQUARTERS DEPARTMENT........	7	....	....	$9,635.7
Executive division	..	....	$669,252.06	....
Designing division	..	*$37.00	657,160.02	....
Laboratory and Inspection division..	..	171.52	161,046.05	....
Totals........................	..	134.52	1,487,458.13	9,635.7
RESERVOIR DEPARTMENT	8	....	....	131,277.4
Indirect damages	..	....	....	149,941.6
Executive division	..	....	102,493.79	....
Relocation of railroads, highways and bridges	..	....	60,390.62	....
Stripping	..	....	47,131.29	....
Topographic surveys	..	....	28,904.57	....
Main dams	..	....	246,287.41	....
Hurley dikes	..	*6.65	5,456.01	....
Totals........................	..	*6.65	490,753.69	281,219.0
NORTHERN AQUEDUCT DEPARTMENT.	9	....	....	....
Executive division	..	*205.08	106,448.43	....
Esopus division	9-A	....	190,279.19	2.3
Wallkill division	9-B	....	104,636.87	1.7
Newburg division.....................	9-C	*1,628.84	62,126.60	13.2
Hudson River division	9-D	*892.69	1,445,349.10	61,539.3
Peekskill division	9-E	....	136,820.53	163.7
Totals........................	..	*2,726.61	2,045,660.72	61,720.4
SOUTHERN AQUEDUCT DEPARTMENT.	10	....	....	....
Executive division	..	*45.33	99,686.06	....
Croton division	10-A	....	128,947.93	8,169.3
Kensico division	10-B	414.36	163,160.30	7,318.2
White Plains division.................	10-C	....	72,172.39	28,250.7
Hill View division	10-D	....	38,440.48	6,730.7
Totals..........................	..	369.03	502,407.16	50,469.1
CITY AQUEDUCT DEPARTMENT.......	7	2,181.92	378,141.39	325,710.37
Executive division	..	....	....	....
Bronx division	..	....	....	....
Manhattan division	..	....	....	....
Conduit and Reservoir division........	..	....	....	....
Appurtenant works	..	....	....	....
Totals.........................	..	2,181.92	378,141.39	325,710.37
LONG ISLAND DEPARTMENT...........	11	....	....	....
Executive division	..	....	66,229.14	....
Topographic surveys	..	....	135,578.00	....
Test borings	..	*11,701.90	74,731.78	....
Stream gaging	..	....	12,344.96	....
Totals.........................	..	*11,701.90	288,883.88	....
RONDOUT SUPPLY......................	12	7,913.56	68,787.53	....
SCHOHARIE SUPPLY....................	12	3,913.83	29,259.29	....
**CATSKILL SUPPLY...................	12	1,313.17	10,697.07	....
PRELIMINARY EXPENSES FROM JUNE 9, 1905 TO JULY 31, 1906.............	13	....	402,138.80	....
Bureau totals.................	..	$1,390.92	$5,704,187.66	$728,754.8

* Credits caused by adjustment of storeroom　　**Catskill Creek watershed

ST ENT 2

U BY DEPARTMENTS AND DIVISIONS

ENT 4		STATEMENT 5			
OF PROPERTY	For Detailed Classification see Statements	PERMANENT CONSTRUCTION		DEPARTMENT TOTALS	
Total to Date		1914	Total to Date	1914	Total to Date
$121,919.28	14	....	....	$9,635.78	$121,919.28
....	..	$155,661.66	$707,768.30	155,661.66	1,377,020.86
....	..	182,948.35	787,622.23	182,911.35	1,444,782.25
....	..	67,354.44	228,863.00	67,525.96	389,909.05
121,919.28	..	**405,964.45**	**1,724,253.53**	**415,724.75**	**3,333,630.94**
5,831,481.82	15	2,143,177.80	18,906,612.15	2,274,455.25	24,738,093.97
382,646.19	..	....	....	149,941.60	382,646.19
....	..	....	....	....	102,498.79
....	..	....	....	....	60,390.62
....	..	....	....	....	47,181.29
....	..	....	....	....	28,904.57
....	..	....	....	....	246,287.41
....	..	....	....	*6.65	5,456.01
6,214,128.01	..	**2,143,177.80**	**18,906,612.15**	**2,424,390.20**	**25,611,493.85**
....	16	....	....	....	....
....	..	20,026.07	178,785.75	19,820.99	285,234.18
164,217.19	16-A	44,159.53	9,458,305.07	44,161.88	9,812,801.45
199,056.88	16-B	59,153.48	6,122,865.67	59,155.26	6,426,559.42
328,687.78	16-C	41,967.07	4,085,696.93	40,351.50	4,476,501.31
349,852.61	16-D	301,334.79	6,689,509.76	361,981.47	8,484,711.47
405,011.46	16-E	373,295.90	5,438,402.17	373,459.62	5,980,234.16
1,446,825.92	..	**839,936.84**	**31,973,555.35**	**898,930.72**	**35,466,041.99**
....	17	....	....	....	....
....	..	31,312.91	177,297.12	31,267.58	276,983.18
580,723.34	17-A	359,503.60	6,697,557.70	367,672.99	7,407,228.97
3,601,926.45	17-B	3,009,343.76	8,206,714.56	3,017,076.87	11,971,801.31
1,841,066.88	17-C	485,226.48	4,425,007.45	513,477.23	6,338,246.72
2,311,331.83	17-D	452,588.80	5,072,570.56	459,319.55	7,422,342.87
8,335,048.50	..	**4,337,975.55**	**24,579,147.39**	**4,388,813.72**	**33,416,603.05**
684,422.24	18	....	....	327,892.29	1,062,563.63
....	..	36,228.72	112,090.92	36,228.72	112,090.92
....	18-A	2,448,602.84	8,553,047.54	2,448,602.84	8,553,047.54
....	18-B	1,413,619.40	8,816,499.35	1,413,619.40	8,816,499.35
....	18-C	903,680.21	1,839,472.69	903,680.21	1,839,472.69
....	..	492,375.26	690,777.24	492,375.26	690,777.24
684,422.24	..	**5,294,506.43**	**20,011,887.74**	**5,622,396.72**	**21,074,451.87**
....	..	....	....	....	....
....	..	....	....	....	66,229.14
....	..	....	....	....	135,578.00
....	..	....	....	*11,701.90	74,731.78
....	..	....	....	....	12,344.96
....	..	....	....	***11,701.90**	**288,883.88**
....	..	....	....	**7,913.56**	**68,787.53**
....	..	....	....	**3,913.88**	**29,259.29**
....	..	....	....	**1,313.17**	**10,697.07**
....	..	....	....	....	**402,128.80**
$16,802,343.95	..	**$13,021,561.07**	**$97,195,456.16**	**$13,751,706.82**	**$119,701,987.77**

	For Details see Statements	Salaries	
		1914	Total to Date
HEADQUARTERS DEPARTMENT	7		
Executive division	..	....	$513,730.04
Designing division	..	....	589,464.46
Laboratory and Inspection division	..	....	103,647.24
Totals	..	....	1,206,841.74
RESERVOIR DEPARTMENT	8		
Executive division	..	....	76,225.80
Relocation of railroads, highways and bridges	..	....	52,758.54
Stripping	..	....	41,456.75
Topographic surveys	..	....	24,061.60
Main dams	..	....	118,679.33
Hurley dikes	..	....	4,152.68
Totals	..	....	317,334.70
NORTHERN AQUEDUCT DEPARTMENT	9		
Executive division	..	....	77,155.3[illegible]
Esopus division	9-A	....	84,692.72
Wallkill division	9-B	....	60,341.5[illegible]
Newburg division	9-C	....	43,197.[illegible]
Hudson River division	9-D	....	666,626.[illegible]
Peekskill division	9-E	....	61,102.[illegible]
Totals	..	....	993,116.9[illegible]
SOUTHERN AQUEDUCT DEPARTMENT	10		
Executive division	..	....	69,138.48
Croton division	10-A	....	69,615.12
Kensico division	10-B	$414.86	94,055.39
White Plains division	10-C	....	53,496.05
Hill View division	10-D	....	22,634.47
Totals	..	414.86	308,939.47
CITY AQUEDUCT DEPARTMENT	7	2,098.73	179,169.67
LONG ISLAND DEPARTMENT	11		
Executive division	..	....	46,637.05
Topographic surveys	..	....	116,114.00
Test borings	..	*236.53	25,451.29
Stream gaging	..	....	8,188.82
Totals	..	*236.53	196,391.16
RONDOUT SUPPLY	12	5,868.76	42,538.57
SCHOHARIE SUPPLY	12	3,722.23	23,606.39
**CATSKILL SUPPLY	12	1,290.27	9,546.45
PRELIMINARY EXPENSES FROM JUNE 9, 1905 TO JULY 31, 1906	13	....	232,538.18
Bureau totals	..	$13,157.81	$3,500,023.36

* Credits caused by adjustment of storeroom

**Catskill Creek wat[illegible]

STATEMENT 3

BY DEPARTMENTS AND D

...IPMENT		CONSUMABLE AND EXPEN...	
	Total to Date	1914	Tot...
	$15,304.16	....	
	13,894.90	....	
	11,841.80	$171.52	
	41,040.86	171.52	
	6,844.39	....	
	11.23	....	
	494.36	....	
	318.46	....	
	11,777.76	....	
	149.63	*6.65	
	19,595.83	*6.65	
	6,112.79	....	
	4,793.89	....	
	2,599.68	....	
	490.01	....	
	69,571.36	....	
	7,867.53	....	
	91,435.26	....	
	3,071.59	....	
	1,490.54	....	
	2,027.29	....	
	337.53	....	
	137.25	....	
	9,064.20	....	
	5,890.96	....	
	976.13	....	
	428.20	....	
	13,697.09	*5,038.50	
	57.84	....	
	15,159.26	*5,038.50	
	2,727.26	1,818.29	
	800.90	190.41	
	164.16	22.90	
	43,819.94	....	
	$230,788.65	*$2,842.08	

CLASSIFIED DISBU

	ENGINEERING SALARIES AND OTHER EXPENSES		ADVERTIS	
	1914	Total to Date	1914	To
HEADQUARTERS DEPARTMENT........	$9,625.78	$121,919.28	....	
RESERVOIR DEPARTMENT.............	93.81	104,868.79	....	$1
NORTHERN AQUEDUCT DEPARTMENT				
Esopus division........................	....	3,342.03	....	
Wallkill division.......................	....	3,675.61	....	
Newburg division......................	....	7,571.04	....	
Hudson River division.................	....	6,360.39	....	
Peekskill division......................	....	920.72	....	
Totals....................	....	21,869.79	....	1
SOUTHERN AQUEDUCT DEPARTMENT				
Croton division........................	....	561.88	....	
Kensico division........................	229.00	42,810.31	$853.80	
White Plains division..................	....	6,869.83	....	
Hill View division......................	....	1,673.98	....	
Totals....................	229.00	51,916.00	853.80	1
CITY AQUEDUCT DEPARTMENT........	....	1,490.00	2,414.20	
INDIRECT DAMAGES....................	16,496.52	33,408.54	154.40	
Bureau totals............	$26,445.11	$335,472.40	$3,422.40	$4

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	For Detailed Classification see Statements	SALARIES 1914	SALARIES Total to Date	EQUI… 1914
HEADQUARTERS DEPARTMENT..	14			
Executive division..............	..	$122,910.91	$567,241.01	$20,335.97
Designing division..............	..	174,027.97	720,518.19	1,544.24
Laboratory and Inspection division	..	43,539.64	163,656.09	1,118.30
Totals	..	340,478.52	1,451,415.29	22,998.51
RESERVOIR DEPARTMENT........	15			
Executive division................	..	55,363.85	287,467.88	3,484.12
Contract 3—Main dams..........	..	81,528.46	353,509.92	35.27
Contract 60—Hurley dikes.......	..	1,761.43	33,817.21	....
Contract 10—Headworks.........	..	7,938.12	47,138.02	150.00
Contract 49—Traver Hollow, Esopus, Bushkill, Boiceville and Olive bridges................	..	346.22	24,131.18	....
Contract 111—Spillway, Stone Church and Beaver Kill bridges	..	1,841.21	10,628.03	....
Contract 76—Ashokan bridge.....	..	2,107.43	2,107.43	....
Contract 72—Clearing and grubbing	..	2,683.50	15,112.41	....
Contract 151—Surfacing highways	.	32,763.03	38,395.50	93.00
Appurtenant works...............	..	4,989.60	10,371.66	....
Contract 48—Part of Kingston sewer	..	....	17,821.62	....
Contract 5—Part of Kingston sewer	..	....	905.33	....
Contract 59 — Construction of highways	..	....	28,544.84	....
Relocation of Ulster and Delaware railroad	..	....	9,735.00	....
Up-keep of structures...........	..	15,920.25	17,116.25	71.25
Totals	..	157,243.10	896,801.78	3,833.64
NORTHERN AQUEDUCT DEPARTMENT...............	16			
Executive division	..	15,775.18	144,073.27	1,329.68
Esopus division	16 A	10,912.69	384,262.44	*871.53
Wallkill division	16-B	10,384.74	268,482.56	*3,491.74
Newburg division	16 C	7,760.49	247,018.78	*1,234.31
Hudson River division..........	16 D	28,693.79	811,235.65	7,953.55
Peekskill division	16 E	20,839.14	465,094.09	*1,134.36
Totals	..	94,366.03	1,820,166.79	2,551.39
SOUTHERN AQUEDUCT DEPARTMENT...............	17			
Executive division	..	25,055.81	138,500.95	1,681.8[illegible]
Croton division	17 A	36,922.15	450,031.74	*1,334.1[illegible]
Kensico division	17 B	89,801.19	441,377.14	977.4[illegible]
White Plains division............	17 C	23,494.06	301,997.42	*581.[illegible]
Hill View division...............	17 D	50,345.19	336,230.40	*74.5[illegible]
Totals	..	225,618.40	1,668,146.65	663.0[illegible]
CITY AQUEDUCT DEPARTMENT	18			
Executive division	..	31,211.30	89,156.30	150.0[illegible]
Bronx division	18-A	107,242.35	372,561.90	204.0[illegible]
Manhattan division	18-B	85,714.35	340,902.31	557.4[illegible]
Conduit and Reservoir division..	18-C	44,590.22	100,837.83	1,144.1[illegible]
Appurtenant works	..	....	612.50	......
Totals	..	268,758.22	904,160.84	2,056.[illegible]
Bureau totals....................		$1,086,464.27	$6,740,691.35	$32,186.4[illegible]

* Credits caused by adjustment of storeroom

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CONSUMABLE AND EXPE 1914	To
$12,414.78	$
7,376.14	
22,696.50	
42,487.42	
12,176.26	
797.48	
90.17	
111.75	
51.79	
70.39	
762.79	
222.76	
2,400.32	
1,113.26	
....	
....	
....	
....	
4,185.13	
21,[illegible].10	
2,921.21	
9,400.02	
13,079.12	
3,288.91	
26,638.37	
4,355.30	
59,[illegible]	
4,575.25	
5,625.29	
16,630.02	
3,029.23	
5,226.43	
35,[illegible].22	
4,966.78	
5,758.11	
7,432.24	
4,246.06	
2,741.26	
25,044.45	
194,493.12	$

STATEMENT 6

Estimated Liabilities on Account of Contracts and Agreements in Force December 31, 1914

Contracts

Contract	Contractor	Estimated Cost	Amount Paid on Account	Amount Retained	Amount Earned	Estimated Liability
	HEADQUARTERS DEPARTMENT					
AE	M. B. Brown Printing & Binding Co.	$15,620.37	$2,758.44	$306.50	$3,064.94	$12,861.93
AF	The J. W. Pratt Company	16,942.10	....	....	....	16,942.10
	RESERVOIR DEPARTMENT					
3	MacArthur Bros. Co. and Winston & Co.	12,669,775.00	11,154,768.15	500,000.00	11,654,768.15	1,515,006.85
10	Jules Breuchaud	1,146,600.00	912,857.61	101,428.62	1,014,286.23	233,742.39
151	State Highway Construction Co.	659,080.00	496,333.71	55,148.19	551,481.90	162,746.29
124	Michael Staub	345,535.00	....	....	....	345,535.00
76	Transit Construction Co.	114,535.00	21,867.75	2,429.75	24,297.50	92,667.25
56	L. K. Comstock & Company	13,370.00	6,375.00	....	6,375.00	6,995.00
31	Ogden Iron and Steel Manufacturing Company	54,900.00	49,410.00	....	49,410.00	5,490.00
112	Vulcan Rail and Construction Company	3,496.50	1,992.35	221.37	2,213.72	1,504.15
	NORTHERN AQUEDUCT DEPARTMENT					
117	Michael Staub	97,987.50	73,349.33	8,149.92	81,499.25	24,638.17
	Wallkill Division					
15	Augustus N. Hand and Stephen L. Selden, Receivers of Elmore & Hamilton Contracting Company	845,634.11	844,046.76	1,587.35	845,634.11	1,587.35
47	The Degnon Contracting Company	4,682,557.88	4,678,875.99	3,681.89	4,682,557.88	3,681.89
	Newburg Division					
18	American Pipe and Construction Co.	756,944.80	750,244.80	6,700.00	756,944.80	6,700.00
45	Pittsburg Contracting Company	1,522,893.34	1,517,210.70	5,682.64	1,522,893.34	5,682.64
	Hudson River Division					
160	Oscar Daniels Company	365,926.00	....	....	....	365,926.00
	Peekskill Division					
2	B. B. Odell, Jr., Receiver of Thomas McNally Company	3,979,242.28	3,972,599.60	6,642.68	3,979,242.28	6,642.68

STATEMENT 6 (*Continued*)

Contract	Contractor	Estimated Cost	Amount Paid on Account	Amount Retained	Amount Earned	Estimated Liability
	SOUTHERN AQUEDUCT DEPARTMENT					
79	Thomas O'Hern	$104,110.00	$91,743.96	$2,952.00	$94,695.96	$12,366.04
55	Rinehart & Dennis Co	4,370,363.90	4,362,847.50	7,516.40	4,370,363.90	7,516.40
121	Joseph Balaban Co	79,000.00	63,950.40	7,105.60	71,056.00	15,049.60
118	A. L. Guidone and Company	110,375.00	14,298.30	1,588.70	15,887.00	96,076.70
	Croton Division					
23	Glyndon Contracting Co	1,111,916.71	1,110,954.23	962.48	1,111,916.71	962.48
24	Bradley Contracting Co	862,067.85	859,081.70	2,986.15	862,067.85	2,986.15
	Kensico Division					
9	H. S. Kerbaugh, Inc., Assignee of John C. Rodgers, James M. Rodgers and John J. Haggerty	7,953,050.00	5,565,085.47	500,000.00	6,065,085.47	2,387,964.53
142	Charles Cochar	11,900.00	8,173.56	908.17	9,081.73	3,726.44
	White Plains Division					
52	Pittsburg Contracting Company	2,025,199.40	2,016,196.80	9,002.60	2,025,199.40	9,002.60
53	Augustus N. Hand and Stephen L. Selden, Receivers of Elmore & Hamilton Contracting Company	1,513,319.57	1,500,265.91	13,053.66	1,513,319.57	13,053.66
	Hill View Division					
54	George W. Jackson, Incorporated	1,479,425.00	1,245,766.50	138,418.50	1,384,185.00	233,658.50
30	Keystone State Construction Company	3,269,280.00	2,670,741.51	296,701.22	2,967,442.73	598,538.49
	CITY AQUEDUCT DEPARTMENT					
146	Coldwell-Wilcox Company	143,142.60	141,581.77	....	141,581.77	1,560.83
105	The Exeter Machine Works	289,130.00	248,539.38	27,615.49	276,154.87	40,590.62
70	Paul S. Reeves and Co	162,788.00	88,624.00	....	88,624.00	74,164.00
	Bronx Division					
63	Mason and Hanger Company	3,709,372.00	3,332,635.03	300,000.00	3,632,635.03	376,736.97
65	Pittsburg Contracting Company	5,590,225.00	4,817,941.07	350,000.00	5,167,941.07	772,283.93
	Manhattan Division					
66	Grant Smith & Co. & Locher	4,512,605.00	4,000,939.10	300,000.00	4,300,939.10	511,665.90
67	Holbrook, Cabot and Rollins Corporation, Geo. B. Fry, Thos. B. Bryson	5,272,435.00	4,445,248.05	250,000.00	4,695,248.05	827,186.95

STATEMENT 6 (*Concluded*)

Contract	Contractor	Estimated Cost	Amount Paid on Account	Amount Retained	Amount Earned	Estimated Liability
	CITY AQUEDUCT DEPARTMENT (*Concluded*)					
	CONDUIT AND RESERVOIR DIVISION					
75	F. V. Smith & Son, Inc.	$234,550.60	$222,823.07	$11,727.53	$234,550.60	$11,727.53
99	Merritt & Chapman Derrick and Wrecking Company	996,862.75	248,916.92	27,657.43	276,574.35	747,945.83
86	Beaver Engineering and Contracting Company	208,908.15	212,050.80	23,561.20	235,612.00	86,857.35
88	Beaver Engineering and Contracting Company	70,186.60	59,613.30	6,623.70	66,237.00	10,573.30
89	Beaver Engineering and Contracting Company	821,130.00	296,150.58	32,905.62	329,056.20	524,979.42
	APPURTENANT WORKS					
41	Ogden Iron and Steel Manufacturing Company	90,670.00	81,603.00	....	81,603.00	9,067.00
42	Coffin Valve Company	151,749.00	133,259.40	....	133,259.40	18,489.60
43	Coffin Valve Company	69,444.25	63,570.48	....	63,570.48	5,873.77
44	Coldwell-Wilcox Company	187,578.00	165,611.28	....	165,611.28	21,966.72
101—Districts 1, 2, 3, 5, 6	The Degnon Contracting Company	201,841.30	172,624.20	14,953.45	187,577.65	29,217.10
94	J. Edward Ogden Company	17,032.50	13,743.98	....	13,743.98	3,288.52
110	Builders Iron Foundry	9,507.00	8,267.31	....	8,267.31	1,239.69
104	Coffin Valve Company	88,600.00	16,049.65	....	16,049.65	72,550.35
156	North-Eastern Forestry Co. and Franklin Forestry Company	26,000.00	8,442.20	....	8,442.20	17,557.80
148	Lord Electric Co.	16,155.60	13,530.76	2,387.78	15,918.54	2,624.84
145	American Cement Tile Mfg. Co.	110,947.00	....	....	....	110,947.00
	Totals	$73,251,907.66	$62,783,561.36	$3,020,606.59	$65,804,167.95	$10,468,346.30

AGREEMENTS

Agreement	Contractor	Estimated Cost	Amount Paid on Account	Estimated Liability
34	Cranford Company	$450,000.00	$78,754.24	$371,245.76
J	New York Telephone Company	1,500.00	1,427.03	72.97
K	New York Telephone Company	8,500.00	4,650.94	3,849.06
L	Herbert D. Pease and A. J. Provost, Jr.	8,000.00	7,333.26	666.74
M	New York Telephone Company	5,000.00	....	5,000.00
95	Giles & Clark	11,100.00	....	11,100.00
	Totals	$484,100.00	$92,165.47	$391,934.53

STATEMENT 6-A

Completed Contracts and Agreements

CONTRACTS REGISTERED

Contract	Contractor	Completed Cost
	ADMINISTRATION BUREAU	
A	The J. W. Pratt Company	$1,713.52
D	Goldman & Steinberg Printing and Publishing Co.	1,668.74
W	Clarence S. Nathan	1,843.88
	POLICE BUREAU	
C	Fiss, Doerr & Carroll Horse Company	8,187.50
O	Fiss, Doerr & Carroll Horse Company	8,437.50
T	Fiss, Doerr & Carroll Horse Company	32,500.00
AB	Fiss, Doerr & Carroll Horse Company	8,937.50
	HEADQUARTERS DEPARTMENT	
B—Class B	The J. W. Pratt Company	1,697.38
B—Class C	Continental Playing Card Co	1,956.50
B—Class D	Joseph N. Early	3,617.50
J—Class A	Keuffel & Esser Co	2,376.00
I	E. J. Brooks & Co	2,518.50
B—Class A	Technical Supply Co	3,995.34
N—Class 1	Alexander Pearson	3,701.46
N—Class 2	John Wanamaker, New York	1,588.19
E	The J. W. Pratt Company	7,982.67
Q	The Martin B. Brown Company	6,897.59
X	Brooklyn Daily Eagle	9,036.90
Y—Class D	Hammacher, Schlemmer & Co	1,297.05
Y—Class O	Keuffel & Esser Co	3,598.74
Z—Class B	Tower Manufacturing & Novelty Company	3,629.25
AA	M. B. Brown Printing & Binding Co	15,373.69
AC	The J. W. Pratt Company	9,386.00
	RESERVOIR DEPARTMENT	
5	Haggerty Contracting Co	13,653.22
48	King, Rice & Ganey Company	171,776.25
59	The C. P. Bower Construction Company	306,193.60
49	The Harrison and Burton Company, Assignee of Harrison and Burton	246,363.20
111	Ward and Tully, Inc	145,138.73
60	MacArthur Brothers Company	806,898.70
72	J. F. Cogan Company, Contractors	383,472.90
	NORTHERN AQUEDUCT DEPARTMENT	
4	Daniel Carpenter	11,095.00
6	John J. McLean	8,965.00
G—Class 2	George D. Harris & Co	319.49
G—Class 1	Parrish, Phillips & Co	23,379.58
H—Class M	Erie City Iron Works	3,374.00
J—Class L	H. W. Palen's Sons	536.81
40	John J. Wilson	11,859.00
J—Class K	Arthur C. Jacobson & Sons	10,585.06
K—Class F	Alden S. Swan and Company	1,798.28
U	Godfrey, Keeler Company	5,380.00
V—Class K	Arthur C. Jacobson & Sons	5,058.09
83	Carpenter & Lindsay	11,256.49
1	The Phoenix Construction Company, Assignee of American Diamond Rock Drill Company	125,320.88
P	Alden S. Swan and Company	1,970.79

STATEMENT 6-A (*Concluded*)

Contract	Contractor	Completed Cost
	NORTHERN AQUEDUCT DEPARTMENT (*Concluded*)	
B	George D. Harris & Co.	$44,233.53
16	King, Rice & Ganey Company	578,624.77
11	H. S. Kerbaugh, Inc., Assignee of H. S. Kerbaugh, Assignee of Stewart-Kerbaugh-Shanley Co.	2,279,324.04
22	James G. Shaw and Benjamin Barker, Receivers of Patterson & Company	724,642.97
80	The Dravo Contracting Company	398,264.18
20	Mason & Hanger Company	3,208,584.74
62	The Snare & Triest Co.	1,601,467.55
58	D'Olier Centrifugal Pump & Machine Co., Assignee of D'Olier Engineering Company	60,664.00
61	The Harrison and Boice Company, Assignee of Harrison and Boice	166,500.14
17	American Pipe & Construction Co.	655,530.60
109	A. L. Guidone and Company	80,185.29
101—District 4	Abner M. Harper, Inc.	48,708.56
12	The T. A. Gillespie Company	6,281,517.19
90	The T. A. Gillespie Company	1,496,363.41
	SOUTHERN AQUEDUCT DEPARTMENT	
7	Shelley Brothers	8,360.00
50	Joseph A. Dassler	11,868.00
74	Joseph A. Dassler	8,065.00
81	John F. Hickey	18,402.00
39	Lord Electric Co.	34,384.00
100	Stobaugh Contracting Company	44,677.24
34	Fox-Hennessy Co.	26,654.52
25	Chas. W. Blakeslee & Sons	1,284,436.15
77	Geo. L. Brown and T. J. Brown	53,352.63
68	The T. A. Gillespie Company, Assignee of David Peoples	1,182,513.81
135	J. E. Butterworth	23,153.24
	CITY AQUEDUCT DEPARTMENT	
73	Sprague & Henwood	58,665.96
98	The Healey Sewer Machine and Construction Company	21,078.01
113	Sweeney & Gray Company	4,933.28
132	Healey Contracting Company	3,769.85
114	Coffin Valve Company	13,405.00
103	Beaver Engineering and Contracting Company	843,813.64
87	Wm. F. Donovan and Charles Cranford	340,893.71
38	The Snare & Triest Co.	92,163.61
84	American Manganese Bronze Company	89,826.53
	APPURTENANT WORKS	
107	The Chapman Valve Manufacturing Co.	123,044.97
93	New York Telephone Company	51,526.31
91	Vulcan Rail and Construction Company	32,123.29
	Total	$23,932,058.19

CONTRACT AGREEMENTS

Completed prior to October 1, 1914

See Statement 6-A, Quarterly Report, dated September 30, 1914... $790,180.09

STATEMENT 7

Classified Disbursements of Headquarters Department by Divisions, and City Aqueduct Department, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive Division		Designing Division		Laboratory and Inspection Division		Totals, Headquarters Department		City Aqueduct Department	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	....	$380,807.88	....	$586,639.04	....	$75,639.91	....	$1,043,086.83	$2,098.73	$140,145.62
Laborers	....	3,175.84	....	330.42	....	27,923.93	....	31,430.19	....	19,836.55
Consulting engineers	....	108,767.02	....	1,980.00	....	....	....	110,747.02	....	3,125.00
Other expert services	....	20,979.30	....	515.00	....	83.40	....	21,577.70	....	16,062.50
EQUIPMENT										
Furniture and fixtures	....	12,251.42	*$37.00	10,226.83	....	1,951.14	*$37.00	24,429.39	....	1,977.00
Engineering instruments and tools	....	1,413.40	....	74.02	....	1,566.29	....	3,053.71	....	2,370.32
Boring rigs, machinery and tools	....	66.03	....	....	....	28.69	....	94.72	....	....
Other machinery, tools, equipment and supplies	....	1,573.31	....	3,594.05	....	8,295.68	....	13,463.04	....	1,543.66
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	....	1,534.14	....	26,474.14	....	13,905.94	....	41,914.22	....	1,892.99
Hardware supplies	....	110.99	....	11.37	....	2,688.89	....	2,811.25	....	57.21
Iron pipe, valves and fittings	....	8.31	....	7.90	....	417.60	....	433.81	....	13.20
Lumber	....	112.37	....	6.00	....	493.80	....	612.17	....	36.21
Fuel and light	....	68.87	....	1.75	$171.52	2,899.48	171.52	2,970.10	....	14.59
Stationery and printing	....	20,865.65	....	4,357.34	....	1,678.68	....	26,901.67	....	1,295.21
Repairs to machinery and other implements	....	147.03	....	160.91	....	452.32	....	760.26	....	55.49
Repairs and maintenance of buildings	....	34.48	....	....	....	....	....	34.48	....	195.95
Team hire	....	147.00	....	9.50	....	63.75	....	220.25	....	236.50
Automobile hire	....	3,308.50	....	22.00	....	....	....	3,330.50	....	....
Traveling expenses including board and lodging	....	11,581.92	....	4,017.54	....	5,341.84	....	20,941.30	....	2,725.85
Postage, telegrams, telephone and miscellaneous expenses	....	29,273.74	....	968.01	....	3,547.78	....	33,789.53	....	1,454.58
Rentals, offices and buildings	....	71,717.31	....	17,764.20	....	6,615.00	....	96,096.51	....	1,598.72
Advertising	....	1,307.55	....	....	....	345.60	....	1,653.15	....	3,113.70
CONTRACTS	....	....	....	....	....	....	....	....	83.19	180,390.54
AGREEMENTS	....	....	....	....	....	7,106.33	....	7,106.33	....	....
Totals	....	$669,252.06	*$37.00	$657,160.02	$171.52	$161,046.05	$134.52	$1,487,458.13	$2,181.92	$378,141.39

STATEMENT 7

Classified Disbursements of Headquarters Department by Divisions, and City Aqueduct Department, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive Division		Designing Division		Laboratory and Inspection Division		Totals, Headquarters Department		City Aqueduct Department	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	....	$380,807.88	....	$586,639.04	....	$75,639.91	....	$1,043,086.83	$2,098.73	$140,145.62
Laborers	....	3,175.84	....	330.42	....	27,923.93	....	31,430.19	....	19,836.55
Consulting engineers	....	108,767.02	....	1,980.00	....	....	....	110,747.02	....	3,125.00
Other expert services	....	20,979.30	....	515.00	....	83.40	....	21,577.70	....	16,062.50
EQUIPMENT										
Furniture and fixtures	....	12,251.42	*$37.00	10,226.83	....	1,951.14	*$37.00	24,429.39	....	1,977.00
Engineering instruments and tools	....	1,413.40	....	74.02	....	1,566.29	....	3,053.71	....	2,370.32
Boring rigs, machinery and tools	....	66.03	....	....	....	28.69	....	94.72	....	....
Other machinery, tools, equipment and supplies	....	1,573.31	....	3,594.05	....	8,295.68	....	13,463.04	....	1,543.66
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	....	1,534.14	....	26,474.14	....	13,905.94	....	41,914.22	....	1,892.99
Hardware supplies	....	110.99	....	11.37	....	2,688.89	....	2,811.25	....	57.21
Iron pipe, valves and fittings	....	8.31	....	7.90	....	417.60	....	433.81	....	13.20
Lumber	....	112.37	....	6.00	....	493.80	....	612.17	....	36.21
Fuel and light	....	68.87	....	1.75	$171.52	2,899.48	171.52	2,970.10	....	14.59
Stationery and printing	....	20,865.65	....	4,357.34	....	1,678.68	....	26,901.67	....	1,295.21
Repairs to machinery and other implements	....	147.03	....	160.91	....	452.32	....	760.26	....	55.49
Repairs and maintenance of buildings	....	34.48	....	....	....	....	....	34.48	....	195.95
Team hire	....	147.00	....	9.50	....	63.75	....	220.25	....	236.50
Automobile hire	....	3,308.50	....	22.00	....	....	....	3,330.50	....	....
Traveling expenses including board and lodging	....	11,581.92	....	4,017.54	....	5,341.84	....	20,941.30	....	2,725.85
Postage, telegrams, telephone and miscellaneous expenses	....	29,273.74	....	968.01	....	3,547.78	....	33,789.53	....	1,454.58
Rentals, offices and buildings	....	71,717.31	....	17,764.20	....	6,615.00	....	96,096.51	....	1,598.72
Advertising	....	1,307.55	....	....	....	345.60	....	1,653.15	....	3,113.70
CONTRACTS	....	....	....	....	....	....	....	....	83.10	180,390.51
AGREEMENTS	....	....	....	....	....	7,106.33	....	7,106.33	....	....
Totals	....	$669,252.06	*$37.00	$657,160.02	$171.52	$101,040.05	$134.52	$1,487,458.13	$2,181.83	$378,141.36

CLASSIFIED DISBURSEMENTS OF NORTHE

(Disb

	EXECUTIVE DIVISION		ESOP
	1914	Total to Date	1914
SALARIES			
Engineering force	....	$76,600.92	......
Laborers	....	28.22	......
Consulting engineers	....	525.00	......
Other expert services	....	1.25	......
EQUIPMENT			
Furniture and fixtures	*$205.08	2,905.71	......
Engineering instruments and tools	....	980.03	......
Boring rigs, machinery and tools	....	30.62	......
Other machinery, tools, equipment and supplies	....	2,196.43	......
CONSUMABLE SUPPLIES AND EXPENSES			
Engineering supplies	....	1,082.64	......
Hardware supplies	....	52.26	......
Iron pipe, valves and fittings	....	.25	......
Lumber	....	.25	......
Fuel and light	....	852.69	......
Stationery and printing	....	3,521.09	......
Repairs to machinery and other implements	....	816.72	......
Repairs and maintenance of buildings	....	....	......
Team hire	....	....	......
Automobile hire	....	5,046.00	......
Traveling expenses including board and lodging	....	3,306.93	......
Postage, telegrams, telephone and miscellaneous expenses	....	4,157.29	......
Rentals, offices and buildings	....	4,394.13	......
Advertising	....	....	......
Personal injuries	....	....	......
CONTRACTS	....	....	......
AGREEMENTS	....	....	......
DAMAGES TO LAND	....	....	......
Totals	*$205.08	$106,448.43	......

* Credits caused by adjustment of storeroom

STATEMENT 9

...QUEDUCT DEPARTMENT BY DIVISION

...nts prior to August 1, 1906 given in Stat...

...ISION	WALLKILL DIVISION		N...
...l to Date	1914	Total to Date	1...
$2,747.98	....	$49,488.29	...
13,571.30	....	9,820.50	...
2,539.99	....	1,187.49	...
33.50	....	345.25	...
1,553.23	....	1,760.18	*$1,...
....	....	523.10	4...
1,395.13	....	70.99	...
1,095.53	....	245.41	*...
1,898.80	....	1,212.65	...
459.61	....	287.69	...
1,000.40	....	287.34	...
1,318.62	....	515.28	...
162.75	....	412.87	...
1,071.55	....	947.86	...
400.21	....	68.65	...
76.00	....	....	...
1,987.32	....	6,051.90	...
....	....	....	...
1,401.85	....	728.01	...
831.53	....	791.76	...
457.00	....	640.00	...
....	....	....	...
....	....	....	...
....	....	....	...
[illegible],570.94	....	27,646.65	...
1,530.00	....	2,105.00	...
[illegible],173.19	....	$104,636.87	*$1,...

STAT

Classified Disbursements of Esopus Division, Northern Aq

(Disbursements prior to A

	Executive		Pre
	1914	Total to Date	1914
SALARIES			
Engineering force	......	$7,461.20	......
Laborers	......	1,124.12	......
Consulting engineers	......	2,275.00	......
Other expert services	......	33.50	......
EQUIPMENT			
Furniture and fixtures	......	1,298.32	......
Boring rigs, machinery and tools	......	31.02	......
Other machinery, tools, equipment and supplies	......	258.68	......
CONSUMABLE SUPPLIES AND EXPENSES			
Engineering supplies	......	370.28	......
Hardware supplies	......	186.17	......
Iron pipe, valves and fittings	......	420.43	......
Lumber	......	272.76	......
Fuel and light	......	106.95	......
Stationery and printing	......	40.94	......
Repairs to machinery and other implements	......	141.45	......
Repairs and maintenance of buildings	......	76.00	......
Team hire	......	1,534.00	......
Traveling expenses including board and lodging	......	904.23	......
Postage, telegrams, telephone and miscellaneous expenses	......	729.37	......
Rentals, offices and buildings	......	400.00	......
AGREEMENTS	......	....	......
DAMAGES TO LAND	......	1,520.00	......
Totals	......	$19,184.42	......

NT 9-A

Department, by Subdivisions, Account Surveys, Maps, Plans, Etc.

906 given in Statement 13)

el	Cut-and-Cover Aqueduct		Grade Tunnel		Steel-Pipe Siphon		Division Totals	
ate	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
.18	......	$33,757.07	......	$1,460.80	......	$978.68	......	$62,747.93
.08	......	6,370.23	......	250.12	......	255.75	......	19,371.30
.99	......	....	......	....	......	....	......	2,539.99
....	......	....	......	....	......	....	......	33.50
.56	......	146.90	......	12.25	......	5.20	......	1,583.23
.11	......	18.00	......	....	......	....	......	1,205.13
.76	......	473.61	......	47.50	......	9.98	......	2,005.53
.27	......	832.78	......	62.89	......	19.58	......	2,686.80
.87	......	104.99	......	8.77	......	.01	......	489.61
.24	......	7.75	......	.06	......	.92	......	1,609.40
.40	......	333.46	......	....	......	....	......	1,318.62
.50	......	....	......	....	......	....	......	762.75
.48	......	540.19	......	57.09	......	35.85	......	1,071.55
.76	......	....	......	....	......	....	......	409.21
...	......	....	......	....	......	....	......	76.00
.82	......	4,111.00	......	269.50	......	171.00	......	9,987.32
.69	......	13.03	......	....	......	....	......	1,011.85
.47	......	16.51	......	1.18	......	....	......	831.53
..	......	57.00	......	....	......	....	......	457.00
.94	......	....	......	....	......	....	......	78,550.94
.00	......	....	......	....	......	....	......	1,530.00
.12	......	$46,782.52	......	$2,170.16	......	$1,476.97	......	$190,279.19

STATEMENT 9-B

Classified Disbursements of Wallkill Division, Northern Aqueduct Department, by Subdivisions, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive		Pressure Tunnel		Cut-and-Cover Aqueduct		Grade Tunnel		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	......	$22,950.26	......	$5,325.32	......	$20,799.30	......	$413.41	......	$49,488.29
Laborers	......	1,697.00	......	1,485.50	......	5,846.00	......	292.00	......	9,320.50
Consulting engineers	......	1,047.50	......	139.99	......	....	......	....	......	1,187.49
Other expert services	......	289.25	......	7.00	......	49.00	......	....	......	345.25
EQUIPMENT										
Furniture and fixtures	......	895.98	......	330.57	......	524.13	......	9.50	......	1,760.18
Engineering instruments and tools	......	65.94	......	175.00	......	156.06	......	126.10	......	523.10
Boring rigs, machinery and tools	......	42.77	......	4.11	......	24.11	......	....	......	70.99
Other machinery, tools, equipment and supplies	......	194.19	......	20.66	......	29.02	......	1.54	......	245.41
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	......	223.90	......	452.08	......	451.31	......	85.36	......	1,212.65
Hardware supplies	......	77.61	......	25.01	......	178.21	......	6.86	......	287.69
Iron pipe, valves and fittings	......	....	......	287.34	......	....	......	....	......	287.34
Lumber	......	205.92	......	99.26	......	210.10	......	....	......	515.28
Fuel and light	......	284.51	......	43.48	......	84.88	......	....	......	412.87
Stationery and printing	......	204.24	......	300.64	......	365.88	......	77.10	......	947.86
Repairs to machinery and other implements	......	14.94	......	15.25	......	38.46	......	....	......	68.65
Team hire	......	1,143.75	......	1,242.00	......	3,540.15	......	126.00	......	6,051.90
Traveling expenses including board and lodging	......	520.63	......	78.70	......	128.68	......	....	......	728.01
Postage, telegrams, telephone and miscellaneous expenses	......	476.81	......	140.49	......	172.34	......	2.12	......	791.76
Rentals, offices and buildings	......	250.00	......	150.00	......	240.00	......	....	......	640.00
AGREEMENTS	......	....	......	24,260.49	......	3,386.16	......	....	......	27,646.65
DAMAGES TO LAND	......	2,105.00	......	....	......	....	......	....	......	2,105.00
Totals	......	$32,690.20	......	$34,582.89	......	$36,223.79	......	$1,139.99	......	$104,636.87

STATEMENT 9-C

Classified Disbursements of Newburg Division, Northern Aqueduct Department, by Subdivisions, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive		Cut-and-Cover Aqueduct		Steel-Pipe Siphon		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES								
Engineering force	......	$16,188.02	......	$24,038.39	......	$813.95	......	$41,040.36
Laborers	......	286.00	......	1,758.10	......	38.40	......	2,082.50
Consulting engineers	......	5.00	......	45.00	......	......	......	50.00
Other expert services	......	18.00	......	7.00	......	......	......	25.00
EQUIPMENT								
Furniture and fixtures	*$1,042.95	......	......	186.45	......	5.86	*$1,042.95	192.31
Engineering instruments and tools	......	66.47	*$340.33	73.60	......	8.46	*340.33	148.53
Boring rigs, machinery and tools	......	40.00	......	......	......	......	......	40.00
Other machinery, tools, equipment and supplies	*245.56	59.24	......	49.93	......	......	*245.56	109.17
CONSUMABLE SUPPLIES AND EXPENSES								
Engineering supplies	......	204.25	......	711.19	......	19.16	......	934.60
Hardware supplies	......	159.46	......	26.06	......	1.07	......	186.59
Iron pipe, valves and fittings	......	.25	......	......	......	......	......	.25
Lumber	......	326.40	......	1.48	......	......	......	327.88
Fuel and light	......	207.13	......	1.50	......	......	......	208.63
Stationery and printing	......	83.92	......	790.81	......	27.34	......	902.07
Repairs to machinery and other implements	......	116.38	......	5.29	......	......	......	121.67
Team hire	......	1,321.25	......	3,429.90	......	80.60	......	4,831.75
Traveling expenses including board and lodging	......	640.46	......	300.75	......	2.30	......	943.51
Postage, telegrams, telephone and miscellaneous expenses	......	243.78	......	50.37	......	10.75	......	304.90
Rentals, offices and buildings	......	277.50	......	454.83	......	21.75	......	754.08
AGREEMENTS	......	596.87	......	7,852.05	......	414.63	......	8,863.55
DAMAGES TO LAND	......	59.25	......	......	......	......	......	59.25
Totals	*$1,288.51	$20,899.63	*$340.33	$39,782.70	......	$1,444.27	*$1,628.84	$62,126.60

*Credits caused by adjustment of storeroom

	EXECUTIVE	
	1914	Total to Date
SALARIES		
Engineering force	....	$25,439.22
Laborers	....	1,701.50
Consulting engineers	....	1,267.50
Other expert services	....	91.95
EQUIPMENT		
Furniture and fixtures	*$892.69	1,485.45
Engineering instruments and tools	....	97.34
Boring rigs, machinery and tools	....	133.62
Other machinery, tools, equipment and supplies	....	195.25
CONSUMABLE SUPPLIES AND EXPENSES		
Engineering supplies	....	1,357.56
Hardware supplies	....	102.11
Iron pipe, valves and fittings	....	49.18
Lumber	....	398.11
Fuel and light	....	1,195.79
Stationery and printing	....	665.27
Repairs to machinery and other implements	....	638.78
Repairs and maintenance of buildings	....	159.48
Team hire	....	1,400.25
Automobile hire	....	....
Traveling expenses including board and lodging	....	1,593.51
Postage, telegrams, telephone and miscellaneous expenses	....	2,469.87
Rentals, offices and buildings	....	3,028.48
Advertising	....	....
Personal injuries	....	....
CONTRACTS	....	8,596.13
AGREEMENTS	....	6,718.20
DAMAGES TO LAND	....	595.00
Totals	*$892.69	$59,379.55

* Credit caused by adjustment of storeroom

...ION, NORT...

(Disbursement...

... Date	Wag...
	1914
...49	
...30	
37.50	
21.00	
...4.44	
...4.10	
...22.70	
...1.21	
...0.31	
...2.64	
...0.22	
...5.37	
...0.62	
...8.29	
...2.93	
...6.67	
...8.11	
......	
250.94	
...861.27	
...207.04	
...146.45	
......	
......	
...900.00	
......	
...420.80	

STATEMENT 9-E

Classified Disbursements of Peekskill Division, Northern Aqueduct Department, by Subdivisions, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive		Cut-and-Cover Aqueduct		Grade Tunnel		Steel-Pipe Siphon		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	......	$4,835.56	......	$28,362.48	......	$5,354.40	......	$13,442.97	......	$51,995.41
Laborers	......	1,059.41	......	4,314.85	......	472.60	......	2,704.00	......	8,550.86
Consulting engineers	......	255.00	......	....	......	....	......	173.36	......	428.36
Other expert services	......	3.20	......	....	......	....	......	125.00	......	128.20
EQUIPMENT										
Furniture and fixtures	......	1,489.81	......	60.15	......	22.05	......	401.27	......	1,973.28
Engineering instruments and tools	......	197.45	......	....	......	....	......	94.67	......	292.12
Boring rigs, machinery and tools	......	60.25	......	92.33	......	....	......	156.66	......	309.24
Other machinery, tools, equipment and supplies	......	4,768.54	......	165.61	......	100.90	......	257.84	......	5,292.89
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	......	384.13	......	204.73	......	155.10	......	239.69	......	983.65
Hardware supplies	......	488.75	......	36.62	......	2.56	......	223.81	......	751.74
Iron pipe, valves and fittings	......	337.10	......	....	......	....	......	1,424.28	......	1,761.38
Lumber	......	290.11	......	182.42	......	....	......	146.92	......	619.45
Fuel and light	......	156.85	......	91.87	......	7.83	......	41.34	......	297.89
Stationery and printing	......	91.21	......	437.52	......	133.13	......	117.73	......	779.59
Repairs to machinery and other implements	......	84.46	......	11.90	......	....	......	9.99	......	106.35
Repairs and maintenance of buildings	......	50.00	......	5.00	......	....	......	19.97	......	74.97
Team hire	......	445.25	......	2,986.16	......	526.10	......	1,488.11	......	5,445.62
Automobile hire	......	14.00	......	26.00	......	13.00	......	....	......	53.00
Traveling expenses including board and lodging	......	1,089.92	......	75.09	......	7.72	......	6.24	......	1,178.97
Postage, telegrams, telephone and miscellaneous expenses	......	601.58	......	87.87	......	16.81	......	30.34	......	736.60
Rentals, offices and buildings	......	1,088.08	......	....	......	11.66	......	....	......	1,099.74
AGREEMENTS	......	....	......	3,336.56	......	2,779.70	......	47,844.96	......	53,961.22
Totals	......	$17,790.66	......	$40,477.16	......	$9,603.56	......	$66,949.15	......	$136,820.53

CLASSIFIED DISBURSEMENTS OF SOUTHERN AQUEDUCT DI

(Disbursements prior to A

	Executive Division		Croton D	
	1914	Total to Date	1914	Tot
SALARIES				
Engineering force	......	$68,326.86	......	
Laborers	......	811.57	......	
Consulting engineers	......	....	......	
Other expert services	......	....	......	
EQUIPMENT				
Furniture and fixtures	*$45.33	3,510.05	......	
Engineering instruments and tools	......	104.38	......	
Boring rigs, machinery and tools	......	....	......	
Other machinery, tools, equipment and supplies	......	1,457.16	......	
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	......	3,066.94	......	
Hardware supplies	......	95.74	......	
Iron pipe, valves and fittings	......	7.90	......	
Lumber	......	245.80	......	
Fuel and light	......	778.59	......	
Stationery and printing	......	3,378.01	......	
Repairs to machinery and other implements	......	1,574.81	......	
Repairs and maintenance of buildings	......	228.00	......	
Team hire	......	79.50	......	
Automobile hire	......	4,507.25	......	
Traveling expenses including board and lodging	......	2,081.24	......	
Postage, telegrams, telephone and miscellaneous expenses	......	3,460.76	......	
Rentals, offices and buildings	......	5,977.00	......	
CONTRACTS	......	....	......	
AGREEMENTS	......	....	......	
DAMAGES TO LAND	......	....	......	
Totals	*$45.33	$99,696.96	......	

*Credit caused by adjustment of storeroom

NT 10

ENT BY DIVISIONS, ACCOUNT SURVEYS, MAPS, PLANS, ETC.

1906 given in Statement 13)

	Kensico Division		White Plains Division		Hill View Division		Department Totals	
te	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
72	$364.36	$76,973.72	......	$42,404.55	......	$19,792.72	$364.36	$267,621.57
75	......	10,719.51	......	6,871.50	......	1,835.50	......	28,512.83
66	......	5,305.00	......	1,470.00	......	1,006.25	......	8,947.91
00	50.00	1,057.16	......	2,750.00	......	....	50.00	3,857.16
09	......	1,388.26	......	....	......	2.68	*45.33	5,979.08
45	......	307.87	......	301.55	......	....	......	719.25
60	......	48.00	......	....	......	....	......	61.60
40	......	283.16	......	35.98	......	134.57	......	2,304.27
03	......	1,955.16	......	618.19	......	165.45	......	6,851.77
31	......	391.23	......	53.77	......	4.56	......	696.11
86	......	83.70	......	....	......	....	......	97.46
24	......	869.40	......	209.94	......	66.04	......	2,138.42
86	......	618.85	......	52.76	......	13.30	......	1,757.36
96	......	1,801.84	......	127.15	......	65.29	......	6,474.25
90	......	74.73	.....	35.10	......	2.56	......	2,010.60
25	......	....	......	....	......	....	......	245.25
17	......	4,962.83	......	1,531.66	......	29.00	......	12,375.16
00	......	236.00	......	127.50	......	164.75	......	5,175.00
35	......	585.96	......	605.57	......	875.74	......	5,141.56
98	......	963.69	......	178.25	......	117.93	......	5,559.99
35	......	1,150.50	......	307.50	......	54.00	......	9,043.35
..	......	....	......	....	......	220.17	......	220.17
13	......	53,358.73	......	14,491.42	......	13,580.97	......	126,254.75
29	......	25.00	......	....	......	309.00	......	362.29
13	$414.36	$163,160.30	......	$72,172.39	......	$38,440.48	$369.03	$502,407.16

STATE

Classified Disbursements of Croton Division, Southern Aqueduc

(Disbursements prior to A

	Executive		Pressure Tu	
	1914	Total to Date	1914	Total
SALARIES				
Engineering force	......	$14,540.21	......	$4
Laborers	......	2,771.50	......	
Consulting engineers	......	665.00	......	
Other expert services	......	50.00	......	..
EQUIPMENT				
Furniture and fixtures	......	993.92	......	..
Engineering instruments and tools	......	3.40	......	..
Boring rigs, machinery and tools	......	9.50	......	..
Other machinery, tools, equipment and supplies	......	334.99	......	
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	......	948.11	......	
Hardware supplies	......	98.98	......	
Iron pipe, valves and fittings	......	....	......	..
Lumber	......	158.37	......	
Fuel and light	......	174.40	......	
Stationery and printing	......	684.16	......	..
Repairs to machinery and other implements	......	222.82	......	
Repairs and maintenance of buildings	......	22.25	......	..
Team hire	......	1,450.57	......	
Automobile hire	......	....	......	
Traveling expenses including board and lodging	......	257.21	......	
Postage, telegrams, telephone and miscellaneous expenses	......	423.77	......	
Rentals, offices and buildings	......	1,092.10	......	
AGREEMENTS	......	....	......	12
DAMAGES TO LAND	......	28.29	......	..
Totals	......	$24,929.55	......	$18

T 10-A

ARTMENT, BY SUBDIVISIONS, ACCOUNT SURVEYS, MAPS, PLANS, ETC.

06 given in Statement 13)

Cut-and-Cover Aqueduct		Grade Tunnel		Steel-Pipe Siphon		Division Totals	
1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
......	$29,271.67	......	$9,809.11	......	$2,422.05	......	$60,123.72
......	3,526.75	......	1,122.50	......	218.00	......	8,274.75
......	20.00	......	25.00	......	136.66	......	1,166.66
......	....	......	....	......	....	......	50.00
......	66.72	......	16.65	......	.80	......	1,078.09
......	2.05	......	....	......	....	......	5.45
......	4.10	......	....	......	....	......	13.60
......	33.96	......	5.95	......	.40	......	393.40
......	82.08	......	9.11	......	2.56	......	1,046.03
......	24.86	......	12.38	......	1.74	......	150.81
......	5.86	......	....	......	....	......	5.86
......	412.19	......	82.25	......	9.25	......	747.24
......	52.46	......	42.95	......	10.06	......	293.86
......	47.68	......	261.54	......	108.58	......	1,101.96
......	78.33	......	14.50	......	4.00	......	323.90
......	....	......	....	......	....	......	22.25
......	2,508.96	......	1,112.66	......	294.49	......	5,772.17
......	11.00	......	45.50	......	15.00	......	139.50
......	434.56	......	108.61	......	69.34	......	993.06
......	237.81	......	115.99	......	13.59	......	839.36
......	239.75	......	182.50	......	10.00	......	1,554.35
......	3,023.13	......	6,365.40	......	22,789.45	......	44,823.63
......	....	......	....	......	....	......	23.29
......	$40,083.92	......	$19,332.60	......	$26,105.96	......	$128,947.93

	Executive		STR
	1914	Total to Date	1914
SALARIES			
Engineering force	....	$12,218.23	....
Laborers	....	1,651.75	....
Consulting engineers	....	3,375.00	....
Other expert services	....	1,007.16	....
EQUIPMENT			
Furniture and fixtures	....	1,339.96	....
Engineering instruments and tools	....	40.53	....
Boring rigs, machinery and tools	....	2.50	....
Other machinery, tools, equipment and supplies	....	240.36	....
CONSUMABLE SUPPLIES AND EXPENSES			
Engineering supplies	....	1,596.91	....
Hardware supplies	....	355.22	....
Iron pipe, valves and fittings	....	2.00	....
Lumber	....	278.66	....
Fuel and light	....	617.19	....
Stationery and printing	....	1,706.84	....
Repairs to machinery and other implements	....	53.65	....
Team hire	....	812.75	....
Automobile hire	....	29.00	....
Traveling expenses including board and lodging	....	140.39	....
Postage, telegrams, telephone and miscellaneous expenses	....	778.65	....
Rentals, offices and buildings	....	1,118.00	....
AGREEMENTS	....	....	....
DAMAGES TO LAND	....	25.00	....
Totals	....	$27,389.25	....

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, SOUTHERN

(Disbursements

	Topog
s Date	1914
8791.60	.....
49.50	.....
250.00	.....
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4.37	.....
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2.45	.....
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....	.....
25.50	.....
....	.....
2.40	.....
5.90	.....
....	.....
....	.....
....	.....
221.72	.....

STATEMENT 10-D

Classified Disbursements of Hill View Division, Southern Aqueduct Department, by Subdivisions, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive		Reservoir		Pressure Tunnel		Steel-Pipe Siphon		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	......	$4,273.55	......	$5,759.05	......	$5,992.55	......	$3,767.57	......	$19,792.72
Laborers	......	220.00	......	478.00	......	854.50	......	283.00	......	1,835.50
Consulting engineers	......	381.25	......	385.00	......	......	......	240.00	......	1,006.25
EQUIPMENT										
Furniture and fixtures	......	2.68	......	......	......	......	......	......	......	2.68
Other machinery, tools, equipment and supplies	......	134.02	......	......	......	55	......	......	......	134.57
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	......	115.33	......	47.62	......	.25	......	2.25	......	165.45
Hardware supplies	......	2.65	......	......	......	.55	......	1.36	......	4.56
Lumber	......	......	......	......	......	7.20	......	58.84	......	66.04
Fuel and light	......	......	......	13.30	......	......	......	......	......	13.30
Stationery and printing	......	65.04	......	.25	......	......	......	......	......	65.29
Repairs to machinery and other implements	......	......	......	2.56	......	......	......	......	......	2.56
Team hire	......	......	......	......	......	4.00	......	25.00	......	29.00
Automobile hire	......	......	......	74.50	......	58.75	......	31.50	......	164.75
Traveling expenses including board and lodging	......	391.71	......	179.28	......	177.13	......	127.62	......	875.74
Postage, telegrams, telephone and miscellaneous expenses	......	29.88	......	24.46	......	42.41	......	21.18	......	117.93
Rentals, offices and buildings	......	4.00	......	......	......	......	......	50.00	......	54.00
CONTRACTS	......	220.17	......	......	......	......	......	......	......	220.17
AGREEMENTS	......	328.84	......	3,043.30	......	1,111.68	......	9,097.15	......	13,580.97
DAMAGES TO LAND	......	309.00	......	......	......	......	......	......	......	309.00
Totals	......	$6,478.12	......	$10,007.32	......	$8,249.57	......	$13,705.47	......	$38,440.46

STATEMENT 11

Classified Disbursements of Long Island Department by Divisions, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Executive Division		Topographic Surveys		Test Borings		Stream Gaging		Department Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	....	$28,208.85	......	$93,982.86	....	$10,987.78	......	$6,638.70	....	$139,818.19
Laborers	....	4,448.70	......	21,233.64	*$236.53	12,393.51	......	1,550.12	*$236.53	39,625.97
Consulting engineers	....	8,600.00	......	800.00	....	2,070.00	......	....	....	11,470.00
Other expert services	....	5,379.50	......	97.50	....	....	......	....	....	5,477.00
EQUIPMENT										
Furniture and fixtures	....	376.26	......	113.54	....	74.51	......	....	....	564.31
Engineering instruments and tools	....	....	......	....	....	123.50	......	....	....	123.50
Boring rigs, machinery and tools	....	259.80	......	5.30	*6,175.62	12,697.36	......	....	*6,175.62	12,962.46
Other machinery, tools, equipment and supplies	....	340.07	......	309.36	*251.25	801.72	......	57.84	*251.25	1,508.99
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	....	2,315.00	......	3,067.85	*835.33	2,036.73	......	1,104.35	*835.33	8,523.93
Hardware supplies	....	20.91	......	300.66	....	453.62	......	3.60	....	778.79
Iron pipe, valves and fittings	....	25.50	......	5.42	*3,865.17	3,385.80	......	....	*3,865.17	3,416.72
Lumber	....	5.48	......	1,223.74	....	2,715.49	......	53.15	....	3,997.86
Fuel and light	....	703.89	......	5.50	....	1,726.02	......	21.16	....	2,456.57
Stationery and printing	....	1,736.72	......	355.94	....	50.13	......	97.91	....	2,240.70
Repairs to machinery and other implements	....	21.15	......	130.32	....	246.36	......	297.80	....	695.63
Repairs and maintenance of buildings	....	26.40	......	....	....	....	......	20.47	....	46.87
Team hire	....	349.25	......	5,890.83	....	2,962.91	......	340.45	....	9,543.44
Automobile hire	....	5,977.40	......	60.00	....	....	......	....	....	6,037.40
Traveling expenses including board and lodging	....	1,899.57	......	5,184.42	....	1,941.26	......	841.32	....	9,866.57
Postage, telegrams, telephone and miscellaneous expenses	....	2,958.94	......	605.36	....	748.21	......	505.69	....	4,818.20
Rentals, offices and buildings	....	991.74	......	2,120.76	....	900.00	......	60.00	....	4,072.50
Advertising	....	1,584.01	......	....	....	....	......	....	....	1,584.01
Department of Water Supply, Gas and Electricity deep-well operations	....	....	......	....	*338.00	....	......	....	*338.00	....
AGREEMENTS	....	....	......	....	....	18,416.87	......	752.40	....	19,169.27
DAMAGES TO LAND	....	....	......	85.00	....	....	......	....	....	85.00
Totals	....	$60,220.14	......	$185,578.00	*$11,701.90	$74,731.78	......	$12,844.06	*$11,701.90	$288,883.88

Classified Disbursements of Rondout, Schoharie and Catskill Watersheds, Account Surveys, Maps, Plans, Etc.

(Disbursements prior to August 1, 1906 given in Statement 13)

	Rondout Supply									
	Reservoir Department		Northern Aqueduct Department		Totals		Schoharie Supply		* Catskill Supply	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES										
Engineering force	$3,404.76	$28,452.51	......	$1,695.78	$3,404.76	$30,148.29	$3,377.47	$19,773.39	$1,290.27	$9,546.45
Laborers	2,464.00	12,290.28	......	......	2,464.00	12,290.28	46.00	3,134.25	......	......
Consulting engineers	......	......	......	......	......	......	130.00	430.00	......	......
Other expert services	......	100.00	......	......	......	100.00	168.75	268.75	......	......
EQUIPMENT										
Engineering instruments and tools	......	153.13	......	1.65	......	154.78	......	152.86	......	152.88
Boring rigs, machinery and tools	165.03	2,142.34	......	......	165.03	2,142.34	......	203.77	......	......
Other machinery, tools, equipment and supplies	61.48	1,430.14	......	......	61.48	1,430.14	1.25	534.27	......	11.28
CONSUMABLE SUPPLIES AND EXPENSES										
Engineering supplies	80.69	1,224.98	......	7.42	80.69	1,232.40	7.30	254.17	......	133.31
Hardware supplies	24.11	97.86	......	......	24.11	97.86	.30	58.37	......	6.66
Iron pipe, valves and fittings	132.39	733.81	......	......	132.39	733.81	......	39.90	......	......
Lumber	15.76	142.22	......	......	15.76	142.22	......	156.48	......	3.00
Fuel and light	418.06	1,438.49	......	......	418.06	1,438.49	1.25	351.94	......	......
Stationery and printing	......	123.76	......	6.18	......	129.94	......	136.12	......	87.56
Repairs to machinery and other implements	281.29	1,064.61	......	......	281.29	1,064.61	.50	4.20	......	.75
Team hire	755.50	6,109.94	......	72.00	755.50	6,181.94	32.00	1,295.97	......	148.76
Traveling expenses including board and lodging	80.45	2,702.54	......	230.44	80.45	2,932.98	148.06	2,127.87	22.90	556.96
Postage, telegrams, telephone and miscellaneous expenses	30.04	250.55	......	......	30.04	250.55	1.00	230.82	......	24.46
Rentals, offices and buildings	......	312.50	......	......	......	312.50	......	106.16	......	25.00
AGREEMENTS	......	8,004.40	......	......	......	8,004.40	......	......	......	......
Totals	$7,913.56	$66,774.06	......	$2,013.47	$7,913.56	$68,787.53	$3,913.88	$29,259.29	$1,313.17	$10,697.07

* Catskill Creek watershed

	Executive Division		Contrac Main Da	
	1914	Total to Date	1914	To
SALARIES				
Engineering force	$38,696.94	$218,303.93	$26,714.46	
Laborers	12,488.25	63,877.29	4,814.00	
Consulting engineers	....	87.50	....	
Other expert services	4,178.66	5,198.66	....	
EQUIPMENT				
Furniture and fixtures	221.60	463.83	....	
Engineering instruments and tools	575.73	1,495.47	....	
Other machinery, tools, equipment and supplies	2,696.79	16,705.77	35.27	
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	806.56	4,661.52	103.06	
Hardware supplies	487.46	958.27	....	
Iron pipe, valves and fittings	104.39	122.52	....	
Lumber	397.82	858.42	....	
Fuel and light	596.82	3,840.75	....	
Stationery and printing	354.56	3,234.30	....	
Repairs to machinery and other implements	191.81	2,043.15	78.00	
Repairs and maintenance of buildings	173.00	1,080.66	.75	
Team hire	3,031.50	14,796.50	389.00	
Traveling expenses including board and lodging	1,069.89	3,691.22	....	
Postage, telegrams, telephone and miscellaneous expenses	1,388.03	7,864.16	46.55	
Rentals, offices and buildings	....	....	....	
Advertising proposals	....	219.96	....	
Repairs and maintenance of automobiles	3,574.42	11,032.10	....	
Repairs and renewals	....	....	....	
Expenses of municipalities in criminal actions	....	....	180.12	
TAXES	18,819.85	114,392.19	....	
CONTRACTS	....	....	904,502.80	11
AGREEMENTS	....	....	....	
Totals	$89,844.06	$474,928.17	$936,864.01	$11

CLASSIFIED DIS

	Execu
	1914
SALARIES	
Engineering force	$15,037.18
Laborers	......
Consulting engineers	......
Other expert services	738.0
EQUIPMENT	
Furniture and fixtures	*169.9
Engineering instruments and tools	......
Boring rigs, machinery and tools	......
Other machinery, tools, equipment and supplies	1,499.6
CONSUMABLE SUPPLIES AND EXPENSES	
Engineering supplies	98.1
Hardware supplies	59.4
Iron pipe, valves and fittings	......
Lumber	4.2
Fuel and light	183.9
Stationery and printing	.
Repairs to machinery and other implements	18.4
Repairs and maintenance of buildings	23.1
Team hire	9.2
Automobile hire	......
Traveling expenses including board and lodging	360.
Postage, telegrams, telephone and miscellaneous expenses	456.
Rentals, offices and buildings	450.
Advertising proposals	......
Repairs and maintenance of automobiles	1,256.
Seeding and fertilizing embankments	......
TAXES	......
CONTRACTS	......
AGREEMENTS	......
DAMAGES TO LAND	......
Totals	$20,026.

* Credits caused by adjustment of storeroom

Classified Disbursements of Esopus Division, [illegible]

	Executive 1914	Executive Total to Date	Contract 62 Esopus and Tongore Siphons 1914	Contract 62 Esopus and Tongore Siphons Total to Date
SALARIES				
Engineering force	$4,871.07	$76,518.95	....	$12,11[illegible]
Laborers	167.00	3,180.31	....	80[illegible]
Consulting engineers	....	68.75	....	.....
Other expert services	....	1,033.33	....	.....
EQUIPMENT				
Furniture and fixtures	*503.61	391.31	....	
Engineering instruments and tools	*37.50	39.09	....	
Boring rigs, machinery and tools	....	....	....	.....
Other machinery, tools, equipment and supplies	*66.15	4,754.90	....	.....
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	*105.40	279.84	....	1[illegible]
Hardware supplies	....	50.56	....	.....
Iron pipe, valves and fittings	....	106.95	....	.....
Lumber	....	24.77	....	.....
Fuel and light	240.60	2,835.44	....	5[illegible]
Stationery and printing	115.80	1,273.35	....	1[illegible]
Repairs to machinery and other implements	485.00	3,460.02	....	1[illegible]
Repairs and maintenance of buildings	....	905.50	....	.....
Team hire	163.00	4,922.89	....	62[illegible]
Automobile hire	6.00	6.00	....	.....
Traveling expenses including board and lodging	19.45	1,420.31	....	[illegible]
Postage, telegrams, telephone and miscellaneous expenses	254.60	5,005.74	....	.....
Rentals, offices and buildings	....	....	....	.....
Advertising proposals	....	1,677.00	....	12[illegible]
Repairs and maintenance of automobiles	86.55	4.860.80	....	.....
Seeding and fertilizing embankments	....	....	....	.....
TAXES	289.73	3,107.08	....	.....
CONTRACTS	....	20,894.00	....	231,331[illegible]
AGREEMENTS	....	5,422.00	....	.....
Totals	$5,986.14	$142,168.89	....	$245,095[illegible]

* Credits caused by adjustment of storeroom ** Credit caused by deduction on voucher

EMENT 16-A

N AQUEDUCT DEPARTMENT, ACCOUNT PERMANENT CO

	CONTRACT 11 COVER AQUEDUCT	CONTRACT 12 RONDOUT PRESSURE TUNNEL		APPURTENANT WOR	
	Total to Date	1914	Total to Date	1914	Total to D
...	$82,969.79	....	$153,201.09	....	$5,275
...	13.598.80	....	25,596.84	....	37
...	....	....	....	....	.....
...	....	....	118.75	....	143
...	778.30	*$149.50	....	....	.....
...	....	*55.00	600.28	....	5
...	....	....	....	....	27
...	67.95	*59.77	1,115.99	....	2,946
...	1,301.04	*316.47	3,575.65	$37.00	1,06
...	14.20	....	95.27	....	.....
...	44.58	....	222.70	....	.....
...	150.00	....	100.82	....	.....
...	438.29	....	464.04	....	7
...	1,223.82	*17.70	2,698.38	....	2
...	139.10	....	264.97	108.62	3,72
...	227.70	....	2.25	....	1
...	7,529.19	12.19	7,267.92	41.25	33
...	....	....	....	....	.....
...	155.74	....	244.45	15.82	3
...	118.08	....	31,860.35	719.76	93
...	36.00	....	....	....	....
...	613.20	....	956.40	372.19	1,00
...	....	....	....	....	....
...	....	....	....	....	....
...	....	....	....	....	....
...	2,279,324.04	**3,143.65	6,283,433.60	26,706.55	133,4
...	....	....	....	865.72	8
...	$2,388,744.82	***$3,729.90	$6,511,814.34	$33,366.91	$159,2'

t caused by adjustment of storeroom and by deduction on vouch

	EXECUTIVE		CONTRACT 47 WALLKILL PRESSURE TUNNEL	
	1914	Total to Date	1914	Total to Da
SALARIES				
Engineering force	$4,099.73	$55,453.17	....	$130,816.
Laborers	366.00	2,626.00	....	23,828.
Consulting engineers	....	68.75	....	......
Other expert services	....	441.67	....	......
EQUIPMENT				
Furniture and fixtures	*5.62	....	*$1,070.04	28.
Engineering instruments and tools	*66.46	....	*15.20	......
Other machinery, tools, equipment and supplies	*2,069.56	1,564.41	....	1,877.
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	84.70	145.24	*304.70	3,667.
Hardware supplies	5.31	69.55	....	107.
Iron pipe, valves and fittings	....	....	....	......
Lumber	13.83	78.71	....	396.
Fuel and light	8.95	520.25	....	956.
Stationery and printing	*57.19	67.12	....	5,128.
Repairs to machinery and other implements	2.44	1,431.91	....	308.
Repairs and maintenance of buildings	31.21	75.53	....	1,561.
Team hire	93.50	750.25	....	10,512.
Automobile hire	....	7.00	....	......
Traveling expenses including board and lodging	13.35	504.22	....	192.
Postage, telegrams, telephone and miscellaneous expenses	166.56	2,076.49	2,442.00	2,596.
Rentals, offices and buildings	222.00	4,002.00	....	1,106.
Advertising proposals	....	....	....	3,351.
Repairs and maintenance of automobiles	953.43	5,584.76	....	......
Seeding and fertilizing embankments	....	....	....	......
TAXES	169.74	1,916.93	....	......
CONTRACTS	....	496.96	**3,681.89	4,678,878.
AGREEMENTS	....	....	....	......
Totals	$4,011.90	$77,870.93	***$2,639.83	$4,864,866.

* Credits caused by adjustment of storeroom ** Credit caused by deduction on vou

EMENT 16-B

ERN AQUEDUCT DEPARTMENT, ACCOUNT PERMA

ACT 15 WE AQUEDUCT Total to Date	CONTRACT 61 WALLKILL BLOW-OFF 1914	CONTRACT 61 WALLKILL BLOW-OFF Total to Date	APPURTENANT 1914	APPURTENANT Tota
$34,807.81	....	$6,493.10	....	
4,421.17	....	18.00	....	
....	....	....	....	
....	....	....	....	
513.11	....	....	....	
....	....	....	....	
582.38	....	.56	....	
660.41	....	5.81	$287.52	
19.42	....	....	....	
....	....	....	....	
277.19	....	....	....	
290.45	....	....	....	
1,881.84	....	6.88	....	
19.29	....	....	....	
614.81	....	....	....	
3,761.97	....	270.00	16.25	
....	....	....	....	
141.22	....	45.09	....	
32.24	....	1.75	....	
15.00	....	....	....	
609.48	....	551.90	29.90	
....	....	....	....	
....	....	....	....	
....	....	....	....	
844,046.76	....	166,500.14	41,827.79	
....	....	....	865.72	
$892,694.55	....	$173,893.23	$43,027.18	

caused by adjustment of storeroom and by deductior

	Executive		Contract 16 Cut-and-Cover Aqueduc[illegible]	
	1914	Total to Date	1914	Total to Da[illegible]
SALARIES				
Engineering force	$1,992.62	$61,339.75	....	$20,687.[illegible]
Laborers	382.00	687.25	....	2,968.[illegible]
EQUIPMENT				
Furniture and fixtures	*22.92	....	*$119.20	265.[illegible]
Engineering instruments and tools	....	....	*71.95	....
Other machinery, tools, equipment and supplies	*285.85	....	....	310.[illegible]
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	8.44	254.52	....	21[illegible]
Hardware supplies	3.79	79.14	....	1[illegible]
Iron pipe, valves and fittings	....	.35	....	....
Lumber	7.64	19.88	....	....
Fuel and light	23.09	574.53	....	1[illegible]
Stationery and printing	2.56	857.97	....	5[illegible]
Repairs to machinery and other implements	1.33	697.19	....	[illegible]
Repairs and maintenance of buildings	....	11.07	....	[illegible]
Team hire	184.50	1,621.90	....	1,6[illegible]
Traveling expenses including board and lodging	77.42	551.46	....	[illegible]
Postage, telegrams, telephone and miscellaneous expenses	381.27	2,351.98	....	1[illegible]
Rentals, offices and buildings	206.00	3,050.50	....	...
Advertising proposals	....	....	....	5[illegible]
Repairs and maintenance of automobiles	5.64	2,971.93	....	...
Seeding and fertilizing embankments	....	....	....	...
TAXES	460.82	3,131.93	....	...
CONTRACTS	....	1,483.24	....	578.[illegible]
Totals	$3,428.40	$79,684.59	*$191.15	[illegible]

* Credits caused by adjustment of storeroom

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ACT 17 AQUEDUC
Total to Da
$32,590.
4,275.
416.
......
277.
52.
19.
......
......
274.
581.
51.
290.
2,340.
50
21
55
524
......
......
......
655,5
$686,94

	Executive 1914	Executive Total to Date	Contract 20 Moodna Pressure Tunnel 1914	Contract 20 Moodna Pressure Tunnel Total to Date
SALARIES				
Engineering force	$5,492.29	$45,995.98	....	$109,497.96
Laborers	15,487.59	17,197.59	....	13,848.50
Consulting engineers	....	262.50	....	....
Other expert services	150.00	439.58	....	....
EQUIPMENT				
Furniture and fixtures	*323.54	6.00	*$74.43	169.53
Engineering instruments and tools	*465.00	323.54	....	288.44
Other machinery, tools, equipment and supplies	7,086.47	8,079.23	....	1,291.18
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	2,887.09	4,274.10	....	978.96
Hardware supplies	792.60	851.21	....	157.15
Iron pipe, valves and fittings	370.17	371.17	....	.75
Lumber	156.12	158.16	....	222.51
Fuel and light	389.27	2,085.41	....	762.95
Stationery and printing	*95.63	648.19	....	1,391.61
Repairs to machinery and other implements	851.44	2,458.71	....	143.60
Repairs and maintenance of buildings	18.91	216.57	....	991.33
Team hire	567.75	2,645.28	....	5,180.25
Traveling expenses including board and lodging	82.36	313.73	....	151.44
Postage, telegrams, telephone and miscellaneous expenses	1,184.29	3,394.05	....	200.54
Rentals, offices and buildings	406.50	4,214.00	....	....
Advertising proposals	....	215.73	....	512.00
Repairs and maintenance of automobiles	5.00	2,094.29	....	....
Seeding and fertilizing embankments	....	....	....	....
TAXES	607.52	4,738.33	....	....
CONTRACTS	....	....	....	3,208,584.74
AGREEMENTS	4,899.00	4,899.00	....	....
DAMAGES TO LAND	....	....	....	50.00
Totals	$40,550.29	$105,327.35	*$74.43	$3,344,423.34

* Credits caused by adjustment of storeroom

STATE[MENT]

CLASSIFIED DISBURSEMENTS OF PEEKSKILL DIVISION, NORTHE[RN]

	Executive		Contract 2 Cut-and-Cover Aqueduct and Grade Tunnels	
	1914	Total to Date	1914	Total to Date
SALARIES				
Engineering force	$7,367.01	$67,004.49	$7,480.63	$322,095.03
Laborers	57.00	93.00	2,003.75	16,650.01
Other expert services	....	416.66	....	137.50
EQUIPMENT				
Furniture and fixtures	6.00	15.43	*758.22	1,528.17
Engineering instruments and tools	....	6.56	*391.54	....
Other machinery, tools, equipment and supplies	142.57	2,575.67	*13.00	2,791.68
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	238.55	567.75	*145.38	3,199.97
Hardware supplies	14.81	53.45	3.99	171.53
Iron pipe, valves and fittings	....	45.93	....	3.18
Lumber	121.13	200.19	....	554.73
Fuel and light	253.96	1,346.07	.60	2,512.55
Stationery and printing	3.71	1,605.13	19.46	2,115.75
Repairs to machinery and other implements	29.99	1,249.85	7.86	1,022.51
Repairs and maintenance of buildings	580.83	712.16	18.90	883.35
Team hire	14.00	207.50	556.00	20,420.00
Automobile hire	....	....	....	9.00
Traveling expenses including board and lodging	17.86	506.93	68.27	654.31
Postage, telegrams, telephone and miscellaneous expenses	155.83	1,974.10	3.05	1,346.44
Rentals, offices and buildings	....	....	....	1,612.67
Advertising proposals	....	1,827.28	....	2,382.80
Repairs and maintenance of automobiles	775.89	4,380.86	....	....
Seeding and fertilizing embankments	....	....	....	....
TAXES	218.65	5,931.60	....	....
CONTRACTS	....	11,095.00	319,490.22	3,972,599.60
AGREEMENTS	....	18,640.00	....	....
Totals	$9,947.34	$120,455.61	$328,344.59	$4,352,690.78

*Credits caused by adjustment of storeroom

T 16-E

UEDUCT DEPARTMENT, ACCOUNT PERMANENT CONSTRUCTION

	ONTRACT 62 Y BROOK, SPROUT K AND PEEKSKILL SIPHONS	APPURTENANT WORKS		UP-KEEP OF STRUCTURES		DIVISION TOTALS	
4	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
....	$50,392.00	$1,968.00	$4,401.98	$125.00	$386.67	$16,940.64	$444,280.17
....	1,116.50	56.63	148.13	1,781.12	2,252.12	3,898.50	20,259.76
....	....	....	....	....	....	....	554.16
4.71	....	....	....	....	....	*766.93	1,543.60
6.46	5.39	....	....	....	....	*585.00	11.95
....	7.59	....	....	88.00	88.00	217.57	5,462.94
5.46	189.71	2.41	113.41	84.91	178.82	145.03	4,244.66
....	8.93	....	....	12.28	21.44	31.08	255.35
....	....	....	....	....	....	....	49.11
....	2.30	....	....	....	....	121.13	757.22
....	269.66	....	....	9.19	9.19	263.75	4,137.47
....	102.16	....	....	....	....	23.17	3,823.04
...	15.43	....	25.00	.50	.50	38.35	2,318.29
...	31.40	....	....	1.34	1.34	550.57	1,628.25
...	1,403.50	56.25	97.25	380.43	429.18	1,006.68	22,557.43
...	....	....	....	....	....	....	9.00
...	48.34	18.84	35.41	70.37	70.37	175.34	1,315.36
[illegible]	485.13	17.54	21.16	269.91	269.91	726.38	4,096.74
...	....	....	....	....	....	....	1,612.67
...	124.45	258.61	367.17	....	....	258.61	4,701.70
...	....	....	....	....	....	775.89	4,380.86
...	....	....	....	239.32	335.32	239.32	335.32
...	....	....	....	....	....	218.65	5,931.60
...	803,141.52	29,526.95	98,664.40	....	....	349,017.17	4,885,500.52
...	....	....	....	....	....	....	18,640.00
31	$857,244.01	$31,905.23	$103,873.91	$3,062.37	$4,037.36	$973,295.90	$5,438,402.17

CLASSIFIED DISBURSEMENTS OF SOUTHERN AQUEDUCT I

	EXECUTIVE DIVISION		CROTON DIVISION	
	1914	Total to Date	1914	Total to D
SALARIES				
Engineering force	$24,218.41	$136,062.68	$30,627.75	$396,61
Laborers	237.40	1,422.27	6,294.40	52,86
Consulting engineers	....	....	....	11
Other expert services	600.00	1,025.00	....	43
EQUIPMENT				
Furniture and fixtures	21.33	622.31	*72.55	1,37
Engineering instruments and tools	175.00	191.00	*268.56	70
Other machinery, tools, equipment and supplies	1,485.52	11,483.04	*998.00	5,98
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	214.42	1,029.22	150.11	6,35
Hardware supplies	67.08	133.23	3.51	40
Iron pipe, valves and fittings	.50	.50	....	4
Lumber	47.15	143.13	2.78	58
Fuel and light	....	471.98	211.94	3,34
Stationery and printing	52.83	678.37	20.41	5,89
Repairs to machinery and other implements	18.70	1,651.23	10.30	1,58
Repairs and maintenance of buildings	6.10	321.48	15.84	44
Team hire	....	14.00	1,641.00	18,75
Automobile hire	....	....	....	7
Traveling expenses including board and lodging	188.84	863.63	432.99	1,48
Postage, telegrams, telephone and miscellaneous expenses	1,636.47	6,019.37	952.51	7,54
Rentals, offices and buildings	900.00	8,511.00	375.00	6,02
Advertising proposals	....	206.50	520.28	5,73
Repairs and maintenance of automobiles	1,443.21	6,447.23	1,288.62	5,04
Seeding and fertilizing embankments	....	....	....	7
TAXES	....	....	355.11	3,62
CONTRACTS	....	....	317,257.64	6,171,74
AGREEMENTS	....	....	677.52	67
DAMAGES TO LAND	....	....	....	....
Totals	$31,312.91	$177,297.12	$359,502.60	$6,697,5

*Credits caused by adjustment of storeroom

T 17

ENT BY DIVISIONS, ACCOUNT PERMANENT CONSTRUCTION

NSICO DIVISION		WHITE PLAINS DIVISION		HILL VIEW DIVISION		DEPARTMENT TOTALS	
14	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
5,301.79	$382,625.29	$17,627.66	$277,136.09	$45,703.19	$308,937.15	$193,378.80	$1,501,374.98
4,511.90	55,733.85	5,866.40	24,648.83	4,192.00	26,612.00	31,102.10	161,284.92
....	....	....	....	....	....	....	112.50
37.50	3,018.00	....	212.50	450.00	681.25	1,187.50	5,374.25
180.49	1,924.36	*502.71	2,351.19	56.27	2,967.60	*317.17	9,264.95
49.25	1,194.95	*95.58	1,655.81	4.45	2,591.50	*135.44	6,342.57
747.71	7,584.69	16.30	3,475.71	*135.25	147.77	1,121.28	28,673.88
1,196.77	13,950.68	96.81	3,611.50	820.54	4,604.68	2,478.65	29,555.41
229.31	490.21	89.74	483.31	52.31	424.71	441.90	1,935.25
4.98	430.48	28.83	44.53	....	32.00	34.31	554.78
11.25	451.20	74.72	704.62	174.25	986.14	310.15	2,881.66
459.15	2,590.10	184.86	2,150.72	428.84	2,158.06	1,284.79	10,712.19
467.45	2,896.23	19.34	2,269.95	168.86	2,003.05	728.89	13,739.42
33.63	382.33	21.63	737.16	42.48	454.82	126.74	4,813.72
255.32	1,010.10	4.27	345.88	76.37	2,787.86	357.90	4,910.68
2,061.00	14,221.95	1,659.00	11,815.00	1,547.00	8,575.00	7,508.00	53,383.17
....	....	....	....	....	....	....	72.00
82.11	742.65	147.36	567.88	162.74	728.50	1,014.04	4,388.96
9,285.94	25,481.52	421.81	3,797.57	1,464.58	6,596.55	13,761.31	49,435.70
400.00	2,372.00	....	2,100.00	....	....	1,675.00	19,003.00
414.64	4,117.83	183.18	2,611.40	281.83	3,016.70	1,399.93	15,683.19
1,128.47	4,572.77	97.68	4,253.24	....	....	3,957.98	20,313.50
....	....	....	....	6.63	52.19	6.63	129.59
1,141.83	36,256.89	3,318.59	12,995.49	....	81,150.40	9,515.53	134,082.00
403.27	7,644,667.48	455,616.59	4,066,689.07	397,091.71	4,617,042.63	4,066,069.21	22,500,147.00
....	....	....	....	....	....	677.52	677.52
....	....	350.00	350.00	....	....	350.00	350.00
343.76	$8,206,714.56	$485,396.48	$4,425,607.45	$452,588.90	$5,072,570.56	$4,337,975.55	$24,579,147.39

	EXECUTIVE		CONTRACT 28 CUT-AND-COVER AQUEDUCT AND GRADE TUNNEL		C GRAD CROTO
	1914	Total to Date	1914	Total to Date	191
SALARIES					
Engineering force	$7,703.52	$64,492.39	....	$55,947.56	...
Laborers	763.40	3,290.85	....	8,961.63	...
Consulting engineers	....	112.50	....	....	...
Other expert services........	....	437.50	....	....	...
EQUIPMENT					
Furniture and fixtures.......	*52.25	395.95	....	125.41	*$
Engineering instruments and tools	*254.28	190.07	....	246.30	*
Other machinery, tools, equipment and supplies	*40.00	4,878.85	....	118.24	*9
CONSUMABLE SUPPLIES AND EXPENSES					
Engineering supplies	*37.04	1,874.79	....	816.55	
Hardware supplies	*2.81	22.07	....	76.47	...
Iron pipe, valves and fittings	....	....	....	12.65	...
Lumber	....	40.14	....	68.44	...
Fuel and light..............	118.50	929.10	....	387.28	...
Stationery and printing......	20.41	2,437.17	....	860.60	...
Repairs to machinery and other implements	1.25	1,039.45	....	110.84	...
Repairs and maintenance of buildings	....	19.04	....	74.15	...
Team hire	183.50	832.00	....	3,394.47	...
Automobile hire	....	....	....	5.50	...
Traveling expenses including board and lodging.......	71.83	486.24	....	234.21	...
Postage, telegrams, telephone and miscellaneous expenses	460.74	3,474.95	$53.42	472.14	
Rentals, offices and buildings.	375.00	3,225.00	....	228.87	...
Advertising proposals	....	1,307.78	....	747.20	...
Repairs and maintenance of automobiles	1,288.62	5,040.26	....	....	...
Seeding and fertilizing embankments	....	....	....	....	...
TAXES	355.11	3,629.22	....	....	...
CONTRACTS	....	21,191.59	**962.48	1,110,964.23	...
AGREEMENTS	....	....	....	....	...
Totals................	$10,956.69	$119,241.96	**$909.06	$1,183,883.74	*$

* Credits caused by adjustment of storeroom   ** Credit caused by deduction on vou

STATEME[illegible]

[illegible] of Croton Division, Southern Aq[illegible]

[illegible] ...to Date	Contract 25 Cut-and-Cover Aqueduct and Grade Tunnel 1914	Contract 25 Cut-and-Cover Aqueduct and Grade Tunnel Total to Date	Cont[illegible] Cut-and-Co[illegible] and T[illegible] 1914
[illegible]	....	$60,591.43	$18,034.3[illegible]
[illegible]	....	9,375.47	2,002.0[illegible]
......	....	....	....
......	....	....	....
[illegible]	*$12.50	164.43	4.7[illegible]
[illegible]	....	45.25	....
[illegible]	....	45.25	....
[illegible]	....	576.46	83.7[illegible]
[illegible]	....	43.81	....
[illegible]	....	16.05	....
[illegible]	....	34.09	1.7[illegible]
[illegible]	....	437.46	81.5[illegible]
[illegible]	....	1,022.59	....
[illegible]	....	17.47	.20
[illegible]	....	31.20	.1[illegible]
[illegible]	....	2,872.17	743.50
[illegible]	....	14.30	....
[illegible]	....	64.28	115.80
[illegible]	....	1,022.46	190.70
[illegible]	....	1,169.58	....
[illegible]	....	901.60	....
......	....	....	....
......	....	....	....
......	....	....	....
[illegible]	....	1,284,436.15	305,442.91
......	....	....	....
[illegible]	*$12.50	$1,362,881.60	$326,651.40

Classified Disbursements of Kensico Divi

	Executive		Contract 55 Cut-and-Cover Aqu Tunnels, Etc	
	1914	Total to Date	1914	Total t
SALARIES				
Engineering force	$15,820.09	$71,412.04	$21,287.50	$141
Laborers	7,513.15	21,120.35	777.50	8
Other expert services	....	2,200.00	....	..
EQUIPMENT				
Furniture and fixtures	103.66	637.04	16.92	
Engineering instruments and tools	30.00	341.00	1.75	
Other machinery, tools, equipment and supplies	*57.43	2,806.42	....	
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	233.59	8,397.25	21.44	
Hardware supplies	39.66	139.98	14.22	
Iron pipe, valves and fittings	*1.63	82.37	6.61	
Lumber	....	82.82	5.00	
Fuel and light	399.01	1,532.34	59.88	
Stationery and printing	219.44	1,052.76	.20	
Repairs to machinery and other implements	26.51	181.42	4.40	
Repairs and maintenance of buildings	.48	83.58	6.35	
Team hire	508.50	1,637.45	786.25	4
Traveling expenses including board and lodging	48.96	425.69	18.05	
Postage, telegrams, telephone and miscellaneous expenses	619.01	4,220.00	38.56	
Rentals, offices and buildings	....	772.00	400.00	1
Advertising proposals	....	1,394.37	....	
Repairs and maintenance of automobiles	1,128.47	4,572.77	....	..
TAXES	5,841.83	36,256.89	....	..
CONTRACTS	....	10,603.65	263,117.59	1,878
Totals	$32,563.30	$164,864.14	[illegible]	$2,840

* Credits caused by adjustment of storeroom

ATEMENT 17-B

THERN AQUEDUCT DEPARTMENT, ACCOUNT PERM

Contract 9 Kensico Dam and Appurtenances		Contracts 34 and 39 Water-Mains, Pumps, Etc.		Appurten
1914	Total to Date	1914	Total to Date	1914
[illegible]5,624.29	$164,385.37	....	....	$2,228.
5,915.75	25,253.00	....	....	120.
87.50	300.00	....	$518.00	......
59.91	563.83	....	....	......
17.50	621.18	....	....	......
805.14	4,576.72	....	....	......
196.35	8,856.92	....	....	16.
4.93	72.94	....	....	170.
....	341.50	....	....	......
6.25	231.43	....	....	......
.26	258.23	....	....	......
247.81	1,259.80	....	....	......
2.72	97.85	....	....	......
4.04	242.25	....	....	244.
694.68	7,371.93	....	....	581.
11.10	197.94	....	76.75	......
1,825.01	21,090.33	....	.50	2.
....	....	....	....	......
....	484.40	....	989.00	414.
....	....	....	....	......
....	....	....	....	......
[illegible],909.16	5,565,065.47	....	61,038.52	33,366.
[illegible],912.49	$5,291,291.09	....	$62,622.77	$37,145.

	Executive		Contract 52 Cut-and-Cover Aqueduct and Tunnels	
	1914	Total to Date	1914	Total to Dat
SALARIES				
Engineering force	$515.50	$35,115.47	$612.84	$107,663.4
Laborers	134.40	2,464.60	36.00	8,292.2
Other expert services	....	212.50	....	....
EQUIPMENT				
Furniture and fixtures	*502.71	133.85	....	1,065.5
Engineering instruments and tools.	*55.58	....	*55.00	722.5
Other machinery, tools, equipment and supplies	*117.42	2,016.28	....	823.9
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	*186.34	44.31	....	1,499.9
Hardware supplies	.92	39.85	....	153.1
Iron pipe, valves and fittings	....	2.52	....	11.1
Lumber	....	36.44	10.33	131.5
Fuel and light	2.58	434.18	2.57	558.7
Stationery and printing	*59.17	38.22	....	977.9
Repairs to machinery and other implements	....	412.69	....	115.1
Repairs and maintenance of buildings	4.27	58.91	....	110.5
Team hire	12.00	270.50	....	4,078.5
Traveling expenses including board and lodging	4.88	208.94	.50	148.1
Postage, telegrams, telephone and miscellaneous expenses	107.91	1,256.27	64.27	811.0
Rentals, offices and buildings	....	660.00	....	....
Advertising proposals	....	487.19	....	589.1
Repairs and maintenance of automobiles	97.68	4,253.24	....	....
TAXES	3,318.59	12,995.49	....	....
CONTRACTS	....	17,718.80	204,000.00	2,016,196.1
DAMAGES TO LAND	....	....	....	....
Totals	$3,277.51	$78,855.25	$204,671.51	$2,143,969.

* Credits caused by adjustment of storeroom

STATEMENT 17-C

Division, Southern Aquedu...

...act 53 ... Siphon and ... Aqueduct Total to Date	Contract 68 Kensico, Elmsf... and Fort Hill Si... 1914	Total ...
$83,132.11	....	$3...
7,479.00	....	
....	....	
903.12	....	
894.14	....	
477.47	....	
1,327.14	....	
177.73	....	
2.76	....	
216.12	....	
546.30	....	
1,019.71	....	
125.88	....	
80.68	....	
4,407.50	....	
83.02	....	
949.81	$28.68	
1,440.00	....	
473.20	....	
....	....	
....	....	
1,500,265.91	....	3...
....	....	
$1,604,091.60	$28.68	$4...

CLASSIFIED DISBU

	EXECUTIVE 1914	EXECUTIVE Total to Date	CONTRAC… BRYN MAWR 1914
SALARIES			
Engineering force	$7,348.52	$36,894.45	....
Laborers	747.75	4,897.25	....
Other expert services	....	231.25	....
EQUIPMENT			
Furniture and fixtures	46.67	2,185.09	....
Engineering instruments and tools.	*15.55	602.68	....
Other machinery, tools, equipment and supplies	*140.50	33.39	....
CONSUMABLE SUPPLIES AND EXPENSES			
Engineering supplies	604.41	2,309.08	....
Hardware supplies	26.53	191.15	....
Iron pipe, valves and fittings	....	....	....
Lumber	174.25	892.28	....
Fuel and light	218.00	1,032.20	....
Stationery and printing	106.43	988.64	....
Repairs to machinery and other implements	4.50	46.21	....
Repairs and maintenance of buildings	42.45	2,390.21	....
Team hire	885.00	4,249.00	....
Traveling expenses including board and lodging	37.16	260.79	....
Postage, telegrams, telephone and miscellaneous expenses	706.43	2,858.34	....
Advertising proposals	....	174.58	....
Seeding and fertilizing embankments	....	....	....
TAXES	....	81,150.40	....
CONTRACTS	....	6,467.25	....
Totals	$10,792.05	$146,894.14	....

* Credits caused by adjustment of storeroom

CLASSIFIED DISBURSEMENTS OF CITY AQUEDUCT DE

	Executive Division 1914	Executive Division Total to Date	Bronx Divisio 1914	Bronx Divisio Total to Date
SALARIES				
Engineering force	$31,048.80	$88,427.63	$107,189.23	$371,150.2
Laborers	....	12.00	....	1,242.5
Consulting engineers	....	200.00	....	....
Other expert services	162.50	516.67	53.12	169.1
EQUIPMENT				
Furniture and fixtures	150.65	727.06	123.65	2,066.2
Engineering instruments and tools	*2.51	622.77	*109.38	3,963.9
Other machinery, tools, equipment and supplies	2.50	4,166.39	189.80	833.5
CONSUMABLE SUPPLIES AND EXPENSES				
Engineering supplies	*52.38	403.83	1,039.96	6,191.
Hardware supplies	3.55	45.98	4.20	105.
Iron pipe, valves and fittings	....	....	106.93	106.
Lumber	....	....	....	3
Fuel and light	17.32	62.89	....	......
Stationery and printing	55.34	831.94	429.24	2,021.
Repairs to machinery and other implements	73.29	135.28	61.94	254.
Repairs and maintenance of buildings	....	99.41	....	2
Team hire	....	....	480.00	485.
Traveling expenses including board and lodging	116.55	569.31	382.00	2,013.
Postage, telegrams, telephone and miscellaneous expenses	988.37	2,858.10	1,785.47	4,271
Rentals, offices and buildings	2,050.00	6,520.00	....	749
Advertising proposals	**7.00	....	....	3,055
Repairs and maintenance of automobiles	1,621.74	5,896.76	1,468.37	3,889
CONTRACTS	....	....	2,335,398.31	8,150,576
Totals	$36,228.72	$112,990.92	$2,448,602.84	$8,553,947

* Credits caused by adjustment of storeroom ** Credit caused by transfer to ap

IT 18

BY DIVISIONS, ACCOUNT PERMANENT CONSTRUCTION

... Division	Conduit and Reservoir Division		Appurtenant Works		Department Totals	
Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
$338,069.73	$44,395.22	$99,390.33	....	$175.00	$268,219.47	$897,232.97
2,625.87	....	1,040.00	....	37.50	....	4,957.87
....	....	....	....	....	....	200.00
276.71	195.00	407.50	....	400.00	588.75	1,770.00
1,663.24	508.71	1,674.18	....	....	857.81	6,130.74
3,929.16	123.88	758.75	....	....	472.20	9,174.61
923.04	516.55	579.80	....	....	726.28	6,502.78
6,179.03	383.51	1,308.97	$1,619.08	1,631.43	5,467.15	15,709.43
42.27	7.22	31.38	....	....	24.92	224.78
93.68	....	479.00	33.86	761.68	234.47	1,441.29
....	2.50	11.50	....	....	2.50	12.22
19.19	3.00	11.71	....	....	24.97	93.79
1,918.38	90.90	661.70	....	....	1,120.94	5,453.49
306.42	39.85	46.35	....	57.66	210.92	799.73
45.00	459.09	540.11	....	....	459.09	686.63
....	....	....	....	....	480.00	485.00
1,323.74	278.39	1,079.97	....	....	1,147.57	4,986.66
4,904.79	874.29	1,983.67	539.78	546.57	6,366.03	14,509.79
2,828.00	250.00	1,216.00	....	....	3,000.00	10,818.00
2,987.75	1,677.62	3,845.06	548.59	2,553.42	2,219.21	12,441.99
2,656.20	179.69	179.69	....	....	4,286.68	12,621.72
3,446,187.15	853,699.79	1,724,262.02	489,634.00	684,613.98	4,998,647.47	19,005,639.25
$3,816,490.35	$903,680.21	$1,839,472.69	$492,375.36	$690,777.24	$5,294,506.43	$20,011,387.74

STATEMENT 18-A

Classified Disbursements of Bronx Division, City Aqueduct Department, Account Permanent Construction

	Executive		Contract 63 Pressure Tunnel from City Line to Burnside Avenue near University Heights		Contract 65 Pressure Tunnel from Burnside Avenue to Eighth Avenue and 99th Street		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES								
Engineering force	$16,442.22	$51,444.66	$34,552.88	$131,032.09	$56,194.13	$188,673.53	$107,189.23	$371,150.28
Laborers	....	....	....	650.50	....	592.00	....	1,242.50
Other expert services	....	18.75	....	33.00	53.12	117.37	53.12	169.12
EQUIPMENT								
Furniture and fixtures	116.50	476.33	7.15	732.13	....	857.80	123.65	2,066.26
Engineering instruments and tools	97.50	171.97	*103.00	1,495.71	*103.88	2,196.25	*109.38	3,863.93
Other machinery, tools, equipment and supplies	....	519.85	112.00	178.62	77.80	135.08	189.80	833.55
CONSUMABLE SUPPLIES AND EXPENSES								
Engineering supplies	443.06	776.77	238.42	2,406.53	358.48	3,007.87	1,039.96	6,191.17
Hardware supplies	.41	8.92	3.79	37.61	....	58.62	4.20	105.15
Iron pipe, valves and fittings	....	....	4.78	4.78	102.15	102.15	106.93	106.93
Lumber	....	....	....	....	....	.72	....	.72
Stationery and printing	207.42	544.19	117.45	698.03	104.37	779.35	429.24	2,021.57
Repairs to machinery and other implements	1.80	54.28	9.92	103.42	50.22	96.32	61.94	254.02
Repairs and maintenance of buildings	....	....	....	2.11	....	....	....	2.11
Team hire	....	5.00	480.00	480.00	....	....	480.00	485.00
Traveling expenses including board and lodging	37.54	228.17	45.97	449.05	298.49	1,336.42	382.00	2,013.64
Postage, telegrams, telephone and miscellaneous expenses	214.85	515.80	359.60	1,347.18	1,211.02	2,408.68	1,785.47	4,271.66
Rentals, offices and buildings	....	....	....	339.00	....	410.00	....	749.00
Advertising proposals	....	....	....	1,513.27	....	1,542.49	....	3,055.76
Repairs and maintenance of automobiles	1,468.37	3,889.07	....	....	....	....	1,468.37	3,889.07
CONTRACTS	....	....	938,435.61	3,332,635.03	1,396,962.70	4,817,941.07	2,335,398.31	8,150,576.10
Totals	$19,029.67	$58,653.76	$974,264.57	$3,474,188.06	$1,455,308.60	$5,020,255.72	$2,448,602.84	$8,553,047.54

* Credits caused by adjustment of storeroom

STATEMENT 18-B

Classified Disbursements of Manhattan Division, City Aqueduct Department, Account Permanent Construction

	Executive		Contract 66 Pressure Tunnel from Eighth Avenue and 99th Street to Broadway and 14th Street		Contract 67 Pressure Tunnel from Broadway and 14th Street to Fort Greene Park, Brooklyn		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES								
Engineering force	$14,959.65	$46,238.90	$24,946.11	$139,847.55	$45,680.46	$152,003.28	$85,586.22	$338,089.73
Laborers	....	....	....	1,515.37	....	1,110.50	....	2,625.87
Other expert services	50.00	50.00	....	29.17	78.13	197.54	128.13	276.71
EQUIPMENT								
Furniture and fixtures	3.80	169.20	....	771.48	76.00	722.56	79.80	1,663.24
Engineering instruments and tools	....	25.00	93.86	1,825.16	366.35	2,079.00	460.21	3,929.16
Other machinery, tools, equipment and supplies	17.43	170.15	....	63.89	....	689.00	17.43	923.04
CONSUMABLE SUPPLIES AND EXPENSES								
Engineering supplies	.25	267.80	1,577.75	3,245.48	899.03	2,665.75	2,477.03	6,179.03
Hardware supplies	....	19.45	3.45	11.73	6.50	11.09	9.95	42.27
Iron pipe, valves and fittings	....	....	79.83	79.83	13.85	13.85	93.68	93.68
Fuel and light	4.65	19.19	....	....	....	....	4.65	19.19
Stationery and printing	....	337.14	100.00	620.35	445.46	960.89	545.46	1,918.38
Repairs to machinery and other implements	.25	.25	8.42	160.80	27.17	145.37	35.84	306.42
Repairs and maintenance of buildings	....	45.00	....	....	....	....	....	45.00
Traveling expenses including board and lodging	12.91	211.18	214.61	618.03	143.11	494.53	370.63	1,323.74
Postage, telegrams, telephone and miscellaneous expenses	381.25	906.56	1,140.78	2,100.13	656.09	1,898.10	2,178.12	4,904.79
Rentals, offices and buildings	700.00	1,412.00	....	443.00	....	473.00	700.00	2,328.00
Advertising proposals	....	....	....	1,338.79	....	1,648.96	....	2,987.75
Repairs and maintenance of automobiles	1,016.88	2,656.20	....	....	....	....	1,016.88	2,656.20
CONTRACTS	....	....	243,185.65	4,000,939.10	1,076,729.72	4,445,248.05	1,319,915.37	8,446,187.15
Totals	$17,147.07	$52,528.02	$271,350.46	$4,153,609.86	$1,125,121.87	$4,610,361.47	$1,413,619.40	$8,816,499.35

STATEMENT 18-A

Classified Disbursements of Bronx Division, City Aqueduct Department, Account Permanent Construction

	Executive		Contract 63 Pressure Tunnel from City Line to Burnside Avenue near University Heights		Contract 65 Pressure Tunnel from Burnside Avenue to Eighth Avenue and 99th Street		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES								
Engineering force	$16,442.22	$51,444.66	$34,552.88	$131,032.09	$56,194.13	$188,673.53	$107,189.23	$371,150.28
Laborers	....	....	....	650.50	....	592.00	....	1,242.50
Other expert services	....	18.75	....	33.00	53.12	117.37	53.12	169.12
EQUIPMENT								
Furniture and fixtures	116.50	476.33	7.15	732.13	....	857.80	123.65	2,066.26
Engineering instruments and tools	97.50	171.97	*103.00	1,495.71	*103.88	2,196.25	*109.38	3,863.93
Other machinery, tools, equipment and supplies	....	519.85	112.00	178.62	77.80	135.08	189.80	833.55
CONSUMABLE SUPPLIES AND EXPENSES								
Engineering supplies	443.06	776.77	238.42	2,406.53	358.48	3,007.87	1,039.96	6,191.17
Hardware supplies	.41	8.92	3.79	37.61	....	58.62	4.20	105.15
Iron pipe, valves and fittings	....	....	4.78	4.78	102.15	102.15	106.93	106.93
Lumber	....	....	....	....	....	.72	....	.72
Stationery and printing	207.42	544.19	117.45	698.03	104.37	779.35	429.24	2,021.57
Repairs to machinery and other implements	1.80	54.28	9.92	103.42	50.22	96.32	61.94	254.02
Repairs and maintenance of buildings	....	....	....	2.11	....	....	....	2.11
Team hire	....	5.00	480.00	480.00	....	....	480.00	485.00
Traveling expenses including board and lodging	37.54	228.17	45.97	449.05	298.49	1,336.42	382.00	2,013.64
Postage, telegrams, telephone and miscellaneous expenses	214.85	515.80	359.60	1,347.18	1,211.02	2,408.68	1,785.47	4,271.66
Rentals, offices and buildings	....	....	....	339.00	....	410.00	....	749.00
Advertising proposals	....	....	....	1,513.27	....	1,542.49	....	3,055.76
Repairs and maintenance of automobiles	1,468.37	3,889.07	....	....	....	....	1,468.37	3,889.07
CONTRACTS	....	....	938,435.61	3,332,635.03	1,396,962.70	4,817,941.07	2,335,398.31	8,150,576.10
Totals	$19,029.67	$58,653.76	$974,264.57	$3,474,138.06	$1,455,308.60	$5,020,255.72	$2,448,602.84	$8,553,047.54

* Credits caused by adjustment of storeroom

STATEMENT 18-B

Classified Disbursements of Manhattan Division, City Aqueduct Department, Account Permanent Construction

	Executive		Contract 66 Pressure Tunnel from Eighth Avenue and 99th Street to Broadway and 14th Street		Contract 67 Pressure Tunnel from Broadway and 14th Street to Fort Greene Park, Brooklyn		Division Totals	
	1914	Total to Date	1914	Total to Date	1914	Total to Date	1914	Total to Date
SALARIES								
Engineering force	$14,959.65	$46,238.90	$24,946.11	$139,847.55	$45,680.46	$152,003.28	$85,586.22	$338,089.73
Laborers	....	....	....	1,515.37	....	1,110.50	....	2,625.87
Other expert services	50.00	50.00	....	29.17	78.13	197.54	128.13	276.71
EQUIPMENT								
Furniture and fixtures	3.80	169.20	....	771.48	76.00	722.56	79.80	1,663.24
Engineering instruments and tools	....	25.00	93.86	1,825.16	366.35	2,079.00	460.21	3,929.16
Other machinery, tools, equipment and supplies	17.43	170.15	....	63.89	....	689.00	17.43	923.04
CONSUMABLE SUPPLIES AND EXPENSES								
Engineering supplies	.25	267.80	1,577.75	3,245.48	899.03	2,665.75	2,477.03	6,179.03
Hardware supplies	....	19.45	3.45	11.73	6.50	11.09	9.95	42.27
Iron pipe, valves and fittings	....	....	79.83	79.83	13.85	13.85	93.68	93.68
Fuel and light	4.65	19.19	....	....	....	....	4.65	19.19
Stationery and printing	....	337.14	100.00	620.35	445.46	960.89	545.46	1,918.38
Repairs to machinery and other implements	.25	.25	8.42	160.80	27.17	145.37	35.84	306.42
Repairs and maintenance of buildings	....	45.00	....	....	....	....	....	45.00
Traveling expenses including board and lodging	12.91	211.18	214.61	618.03	143.11	494.53	370.63	1,323.74
Postage, telegrams, telephone and miscellaneous expenses	381.25	906.56	1,140.78	2,100.13	656.09	1,898.10	2,178.12	4,904.79
Rentals, offices and buildings	700.00	1,412.00	....	443.00	....	473.00	700.00	2,328.00
Advertising proposals	....	....	....	1,338.79	....	1,648.96	....	2,987.75
Repairs and maintenance of automobiles	1,016.88	2,656.20	....	....	....	....	1,016.88	2,656.20
CONTRACTS	....	....	243,185.65	4,000,939.10	1,076,729.72	4,445,248.05	1,319,915.37	8,446,187.15
Totals	$17,147.07	$52,528.02	$271,350.46	$4,153,609.86	$1,125,121.87	$4,610,361.47	$1,413,619.40	$8,816,499.85

STATEMENT [illegible]

Total Disbursements for Acquisition of Property Pursuant to Condemnation Proceedings and Private Purchase; Also Disbursements for Indirect Damages, Indicating the Attendant Expense Incurred for Acquisition by Percentages

		Acquisition of Property			Indirect Damages		
			Per Cent. of Total	Per Cent. of Expenses to Awards		Per Cent. of Total	Per Cent. of Expenses to Awards
AWARDS							
50 per cent. payments to obtain possession	$183,895.31	....	......	......	....	......	......
Final awards	10,189,884.97	....	......	......	$135,006.88	45.80	......
Purchased under contract	296,165.86	....	......	......	....	......	......
Total awards, etc.		$10,669,946.14	64.64	......	....	......	......
Interest on awards		1,648,801.95	09.99	15.45	....	......	......
Advertising		443,946.46	02.69	04.16	2,647.74	00.90	01.96
Commissioners' fees		1,062,498.72	06.44	09.96	75,350.00	25.56	55.81
Expenses of commissioners		79,898.40	00.48	00.75	2,347.44	00.80	01.74
Stenographers and other clerks		62,606.70	00.38	00.59	3,554.93	01.21	02.63
Special counsel fees		358,679.20	02.17	03.36	35,372.25	12.00	26.20
Special counsel expenses		27,493.06	00.17	00.26	1,711.42	00.58	01.27
Obtaining orders for 50 per cent. deposits		8,375.00	00.05	00.08	....	......	......
Closing title		1,370.00	00.01	00.01	....	......	......
Counsel fees on appeal		3,275.00	00.02	00.03	....	......	......
Costs on appeal		4,499.97	00.03	00.04	1,275.12	00.43	00.95
Searching titles		211,138.64	01.28	01.98	....	......	......
Disbursements for preparing abstracts		125,312.50	00.76	01.17	....	......	......
Appraisers' fees		482,512.53	02.92	04.52	13,153.00	04.46	09.74
Appraisers' expenses		5,792.72	00.03	00.06	1,132.09	00.38	00.84
Rent of New York office		26,269.40	00.16	00.25	....	......	......
Stenographic services and printing testimony		265,684.24	01.61	02.49	21,383.95	07.25	15.84
Counsel fees of parcel owners		384,405.99	02.33	03.60	....	......	......
Expenses and disbursements of parcel owners		261,275.36	01.58	02.45	1,866.50	00.63	01.38
Engineering salaries and expenses		373,760.65	02.26	03.50	....	......	......
Totals		**$16,507,542.63**	**100.00**	**54.71**	**$294,801.32**	**100.00**	**118.36**

ACQUISITION OF PROPERTY	$16,507,542.63
INDIRECT DAMAGES	294,801.32
Total	**$16,802,343.95**

STATEMENT B

Showing Acreage of Land to be Taken for Construction Purposes, Disbursements for Acreage Upon Which Awards Have Been Paid, Expenses Incidental Thereto, the Percentage of Expenses to Awards and Average Price and Expense Per Acre

	Acreage: Total to be Taken	Acreage: Final Awards Paid	Acreage: Balance to be Acquired	Amount of Awards Paid	Amount of Expenses Paid	Total Awards and Expenses	Average Award Per Acre	Average Expense Per Acre	Per Cent. of Expenses to Awards
Ashokan reservoir	15,221.305	14,905.655	315.650	$3,622,445.20	$2,296,881.49	$5,919,326.69	$243.02	$154.09	63.41
Northern Aqueduct	1,637.351	1,610.448	26.903	757,171.92	689,654.00	1,446,825.92	470.16	428.24	91.08
Southern Aqueduct	956.566	956.566	....	1,900,465.63	753,718.99	2,654,184.62	1,986.75	787.94	39.66
Kensico reservoir	3,181.762	3,179.462	2.300	2,357,705.24	1,253,554.43	3,611,259.67	741.54	394.27	53.17
Hill View reservoir........	163.380	163.380	....	1,437,152.00	632,452.21	2,069,604.21	8,796.38	3,871.05	44.01
City Aqueduct	166.332	*166.332	....	595,006.15	89,416.09	684,422.24	6,584.84	989.55	15.03
Headquarters	....	....	....	....	121,919.28	121,919.28	....	....	.....
Totals	21,326.696	20,981.843	344.853	$10,669,946.14	$5,837,596.49	$16,507,542.63	$508.53	$278.22	54.71

* The City was vested with the fee of 75.972 acres of this land when the taking maps were prepared. The amounts for awards and expenses are therefore computed for 90.360 acres

Statements appended, D and E, indicate the result in those sections in which the proceedings have been concluded

COMPARATIVE COST OF ACQUIRING REAL ESTATE PURSUANT T

	Section 3		
Number of parcels	....	....	53
Acreage	....	....	234.051
Awards	....	$33,775.00	....
Other expenses	....	54,470.39	....
Total awards and expenses	....	....	$88,245.39
Average award per parcel	....	$637.26	....
Average expense per parcel	....	1,027.74	....
Total	....	....	$1,665.00
Average award per acre	....	$144.31	....
Average expense per acre	....	232.72	....
Total	....	....	$377.03
Per cent. of expenses to awards	....	....	161.27

	Section 3		
	Amount	Per Cent. of Total	Per Cent. of Other Expenses to Awards
Awards	$33,775.00	38.28	....
Interest on awards	3,522.97	03.99	10.43
Counsel fees of parcel owners	1,118.00	01.27	03.31
Expenses and disbursements of parcel owners	1,876.24	02.13	05.56
Searching titles	5,675.58	06.43	16.80
Preparing abstracts	2,425.00	02.75	07.18
Advertising	16,494.62	18.69	48.84
Commissioners of appraisal fees	8,455.00	09.58	25.03
Commissioners of appraisal expenses	855.91	00.97	02.53
Stenographers and other clerks to commissioners	1,343.25	01.52	03.98
Special counsel fees	5,175.98	05.86	15.32
Obtaining order for 50 per cent. deposit	925.00	01.05	02.74
Closing title	100.00	00.11	00.30
Counsel fees on appeal	....	....	....
Special counsel expenses	265.76	00.30	00.78
Appraisers' fees	4,052.56	04.59	12.00
Appraisers' expenses	....	....	....
Stenographic services and printing testimony	2,184.52	02.48	06.47
Totals	$88,245.39	100.00	161.27

REPORT OF THE CHIEF ENGINEER

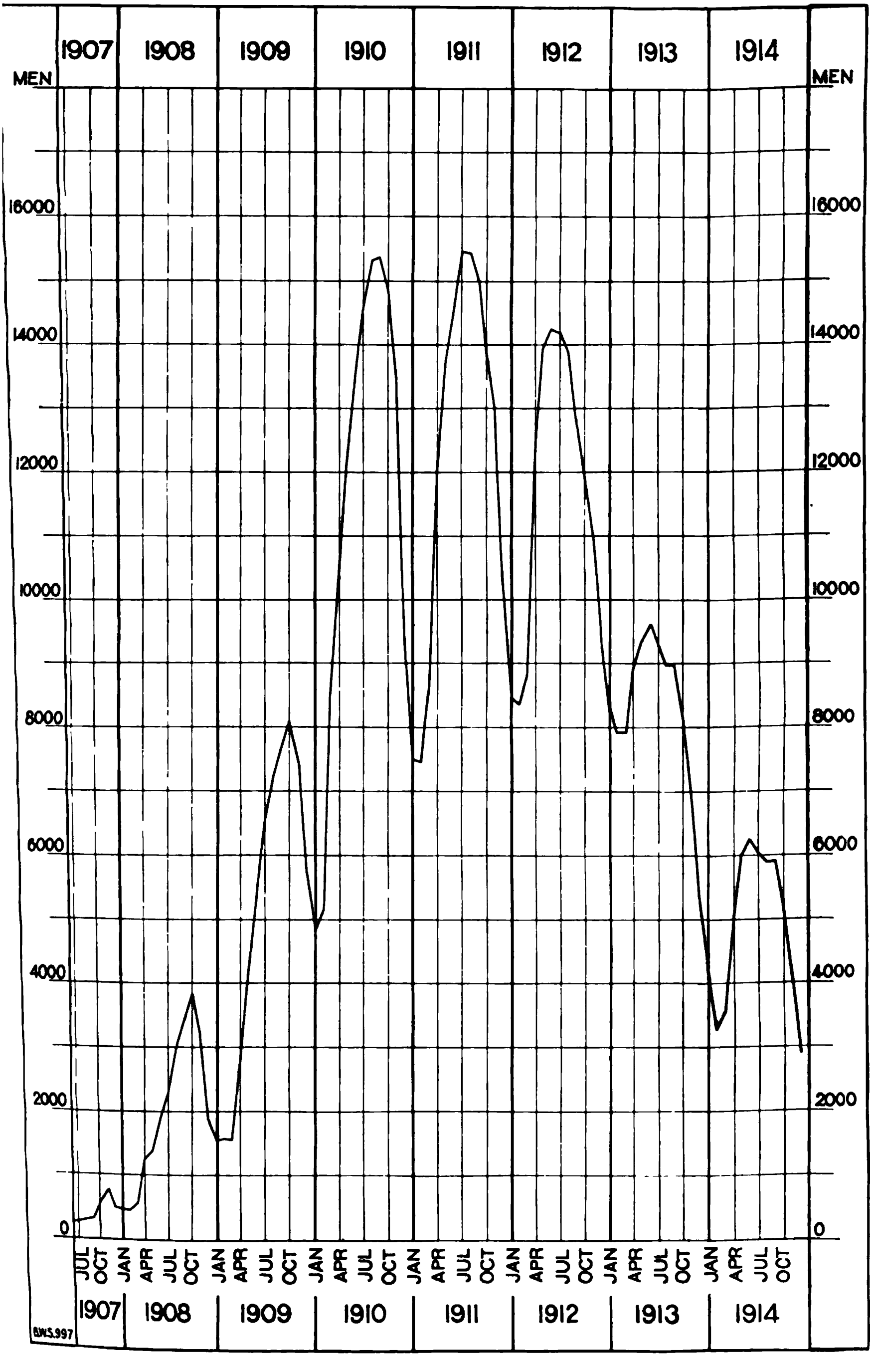
George W. Tillson, Consulting Engineer, Borough of Brooklyn, representing a committee of the Board of Estimate and Apportionment, was consulted at intervals regarding the construction of the relocated highways around Ashokan reservoir.

Contracts completely prepared during the year, 12 in number and aggregating $1,588,000 in value, were: for Ashokan bridge to connect the highways on the north side of Ashokan reservoir with those on the south; for furnishing, delivering and planting tree transplants at Ashokan and Kensico reservoirs; for the construction of Moodna Siphon supplementary shaft and tunnel; for the operation of the Catskill Aqueduct telephone system between Croton lake and New York City; for superstructures at Ashokan Upper and Lower Gate, Screen and Gaging chambers, Esopus and Tongore siphon chambers and balustrades and cartouches for Ashokan bridge; for superstructures at Sprout Brook, Peekskill, Hunters Brook, Turkey Mountain and Harlem Railroad siphon chambers and Croton Gaging chamber; for roofing with reinforced-concrete tiles the preceding and other superstructures, 46 in all; for cutting about 8,000 square feet of facing stones for Kensico dam; for controlling, flap and pressure-regulating valves, sluice-gates and appurtenances for Croton Lake siphon and City aqueduct; for 2.4 miles of Queens conduit; for 0.8 mile of Richmond conduit; and for printing for 1915 and 1916. There were also nine agreements prepared.

Contracts, the preparation of which was well advanced, were: for a plant for removal of color and turbidity in Southern Aqueduct department; for superstructures at Kensico siphon, Kensico Influent, Upper and Lower Effluent and Screen chambers; for riser-valve controlling apparatus; for making connections between valve shafts and riser-valve control posts, and for operating equipment for City Tunnel chambers.

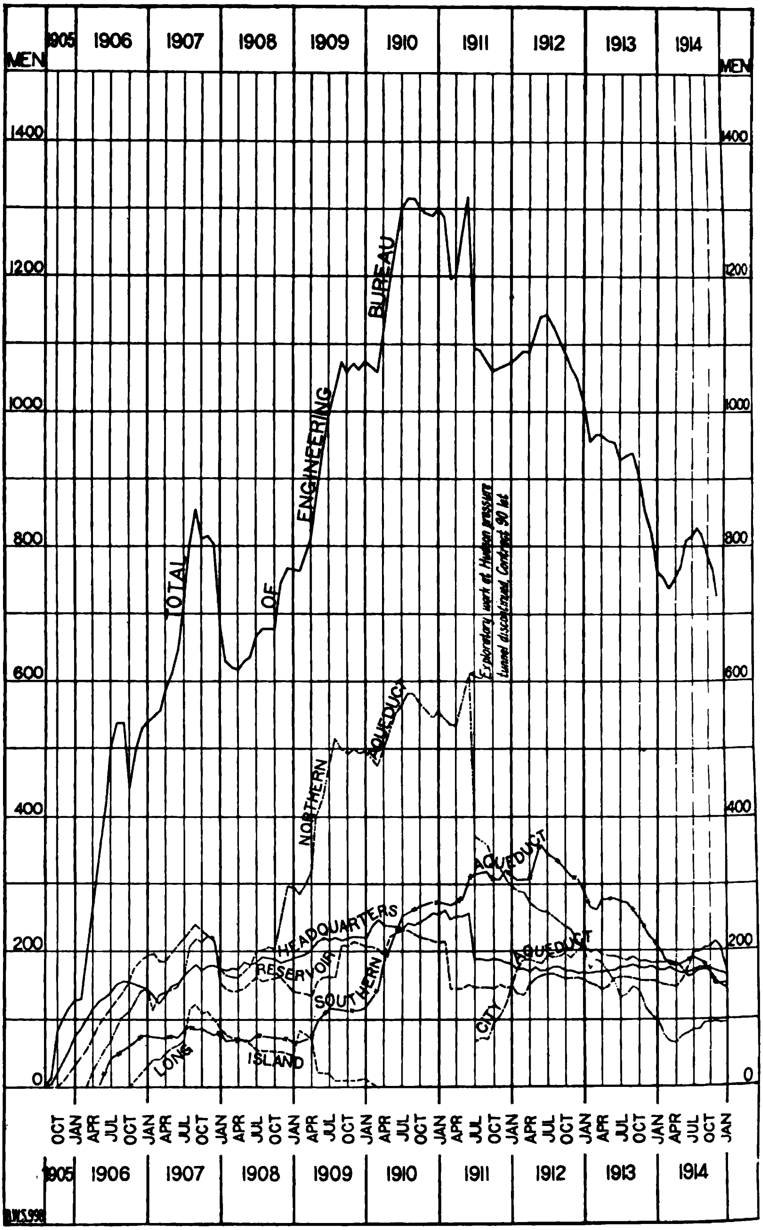
Working drawings were made for the approaches, substructure and superstructure of Ashokan bridge; for Kensico bridge over the Waste channel adjoining Kensico dam; for Moodna Siphon supplementary shaft and tunnel, and for setting the cover on Hudson Siphon Drainage shaft and for grading in the vicinity of the Drainage chamber.

With the award during the year of contracts for the construction of portions of Richmond and Queens conduits, of the Narrows siphon and of Moodna Siphon supplementary shaft and tunnel, the last links in the 126-mile waterway connecting Ashokan reservoir, in the Catskills, with the Borough of Queens and with Silver Lake reservoir, on Staten Island, were placed under contract.



FLUCTUATIONS IN CONTRACTORS' FORCES

SHEET 3



FLUCTUATIONS IN ENGINEERING BUREAU FORCES

The entire waterway length was largely completed at the end of 1914, though many details still remained to be done. A small supplementary portion of the Moodna tunnel, 900 feet long, just west of the Hudson river, was under construction. Of the pipe-line crossing the Narrows from Brooklyn to Staten Island, 10,570 feet long, about 40 per cent. was laid. Completed portions of the aqueduct are now undergoing operating tests.

Investigations were continued by Board's forces and with Board equipment to determine suitable dam sites for impounding reservoirs in the Rondout watershed.

Following the approval by the State Conservation Commission, on October 21, 1914, of the development of the Schoharie watershed, an agreement was prepared under which work was begun by boring contractors for investigating possible dam sites on Schoharie creek near Prattsville. Board forces and equipment were later sent to this locality and commenced supplementary investigations down-stream from the above site.

It is estimated that of the total work under way within the City limits, including Silver Lake reservoir, 92 per cent. is completed; 23 per cent. was performed during the year.

The total force in the Engineering bureau of the Board of Water Supply, numbering 724 on December 31, consisted of 182 engineers, 218 engineering assistants and inspectors, 94 stenographers and clerks, 199 laborers and 31 gage-keepers.

The contractors' maximum daily forces actually at work in the field in any one day exceeded 6,730, while the minimum was about 3,470. These figures do not include men in the contractors' camps temporarily idle, nor those engaged indirectly on the work in cement-mills, foundries, machine and repair-shops and other manufacturing establishments.

HEADQUARTERS DEPARTMENT

THADDEUS MERRIMAN, *Department Engineer*

ORGANIZATION

DIVISIONS AND EMPLOYEES

The organization of the department remained unchanged, with the exception of the department head who was appointed August 1, 1914, to succeed Alfred D. Flinn, promoted to be Deputy Chief Engineer.

DIVISION HEADS IN HEADQUARTERS DEPARTMENT
DECEMBER 31, 1914

Executive division—Percy C. Barney, Principal Assistant Engineer; W. J. Buhrendorf, Chief Clerk.

Designing division—Thomas H. Wiggin, Senior Designing Engineer; Fred F. Moore, Second Designing Engineer; J. Howard Williams, Mechanical Engineer; Clarence F. Bell, Assistant Engineer in charge of Drafting; H. Lincoln Rogers, Architect.

Inspection division—Ernst Jonson, Engineer Inspector.

Real Estate division—Royal W. Gilkey, Real Estate Engineer.

EMPLOYEES IN HEADQUARTERS DEPARTMENT—1914

	January 1	December 31	Maximum	Minimum
Engineers and clerks..........	162	159	172	159
*Laborers	8	6	8	6

*Includes two gage keepers

OFFICES

The entire force of the department is now housed on the twenty-second floor of the Municipal Building, with the exception of the Inspection division and photographic laboratory which remained in the two-story and basement building at 147 Varick street, and of inspectors detailed to mills and manufacturing plants or supervising construction.

CIVIL SERVICE

The maximum number of employees in the entire Engineering bureau of the Board during the year was reached August 31, being

828. The minimum number during the year was 724 on December 23. A schedule of employees in the Engineering bureau on January 1 and December 31 forms Table 1, and the fluctuation in the force by departments appears on Sheet 3.

Connected with civil service matters was the compilation, for the use of the Commission of Pensions, of data concerning all past and present employees of the Board.

CLASSIFICATION OF APPOINTMENTS AND SEPARATIONS DURING 1914

Class	Made	Rescinded	Reported	Separated
Exempt	1	..	1	4
Competitive	118	24	94	166
Labor	125	19	106	75
Temporary and exceptional	178	24	154	139
Totals	422	67	355	384

Equipment and Supplies

Continuing precedent, all equipment and supplies for the Engineering bureau were requisitioned and distributed, as were the salary checks of the Engineering and Police bureaus.

Quarterly reports showing additions and deductions to the inventory submitted to the Comptroller as of December 31, 1912, were prepared and forwarded to the Auditor; the semi-annual storeroom reports were made as of January 1 and July 1 in order to coincide with the dates of the quarterly financial statements.

SUMMARY OF REQUISITIONS, BILLS AND CONTRACT ESTIMATES FOR 1914

	Number	Items	Amount
Field requisitions received	656	3,433	....
Requisitions issued	793	2,243	....
Shipments made	181	...	....
Bills for supplies passed	2,833	...	$159,491.98
Estimates on supply contracts passed	12	...	4,516.45
Estimates on construction contracts passed	323	...	*11,664,443.91

*For value of work done see Contracts and Agreements; this sum comprises some 1913 estimates passed in 1914

PRELIMINARY WORK

Experimental Work

Cement Tests.—In order to investigate the value of the autoclave or high-pressure steam test for cement which has recently received much publicity, 68 bars, 6 inches by 1 inch, and 428 standard briquettes, made with all brands of cement being used in the

Catskill water-works, were tested in this apparatus. Twenty-eight per cent. of the cement that had already passed the Board's specifications passed the autoclave requirements.

Briquettes made of one part of cement and four parts of standard Ottawa sand were immersed in water which percolated into the rock portion of some of the shafts containing about 40 parts of free sulphur per million. The strength of briquettes at 7 and 28 days and 3, 6 and 12 months, was not appreciably affected as compared with briquettes stored in water drawn from the tap at the laboratory.

Tests to determine the effect of excess water on concrete made with granite and limestone aggregates were continued. The 3-month and 1-year tests indicated that concrete mixed as wet as is common in reinforced-concrete work, had 20 per cent. less strength than concrete of a plastic mix.

Electrolysis in Steel-Pipe Siphons.—Danger to these structures from the presence of stray electric currents which might subject them to electrolytic corrosion prompted a survey of conditions offering such a menace.

A suitable case was found at Bryn Mawr siphon where a series of pertinent electrical measurements was made.

A grounded trolley-line crosses the siphon at Tuckahoe road and it was determined by actual test that stray currents from the track leave the rails at this point and pass into the steel pipe.

Voltage readings taken between the siphon manhole just north of Tuckahoe road and the gas-main, water-main and trolley tracks which occupy it, showed that the steel-pipe siphon is electro-negative to these three conductors indicating that current is flowing into the steel-pipe siphon at Tuckahoe road from these three sources.

SUMMARY OF VOLTAGE READINGS

Gas-Main	Water-Main	Trolley Tracks	Manhole at Station 695
+1.0 to 4.0 volts	+0.5 to 1.2 volts	+6.0 to 12.0 volts	Electro-negative

It is well known that electrolytic action by stray currents does not take place at the points of entrance to an underground metallic structure, but at the points of exit of such currents. When current passes through earth electrolytic corrosion usually takes place whether the metal is embedded in concrete, as in the case of the

steel-pipe siphons, or not. Further tests along the siphon indicated that stray currents do not enter the steel pipe from any other source. In order to ascertain where these stray currents leave the siphon, several voltage readings were then taken at other siphon manholes and at adjacent structures.

It was found that at all locations except Tuckahoe road, the steel pipe is electro-positive to neighboring structures indicating that electric current is leaving the steel pipe at many points.

At the Bryn Mawr Connection chamber it was found that electric current leaves the steel-pipe siphon and enters the mains of the Yonkers water-supply, through a 2-inch pipe supplying the hydraulic cylinders of the valves, returning through the water-mains to the railroad company's substations. As the stray current passes from the steel-pipe siphon directly to the water-pipe without passing through earth, no electrolytic action takes place at this point.

Leading Joints of 36-Inch Cast-Iron Flexible-Jointed Pipe. Narrows Siphon.— Experiments on the flow of cold lead under pressure, using blocks of iron bolted together with space between, corresponding to the section of joint in the pipe, as designed, were started primarily to develop a hydraulic-plunger method of inserting the lead through holes in the joint as a substitute for the gib screws shown on the contract drawing. The results caused doubt as to the adequacy of the design proposed for use with respect to the position of the ridge on the spigot and the position of the gib-screw holes. This design differed from that of the experimental section in the position of the 16 screws for injecting lead.

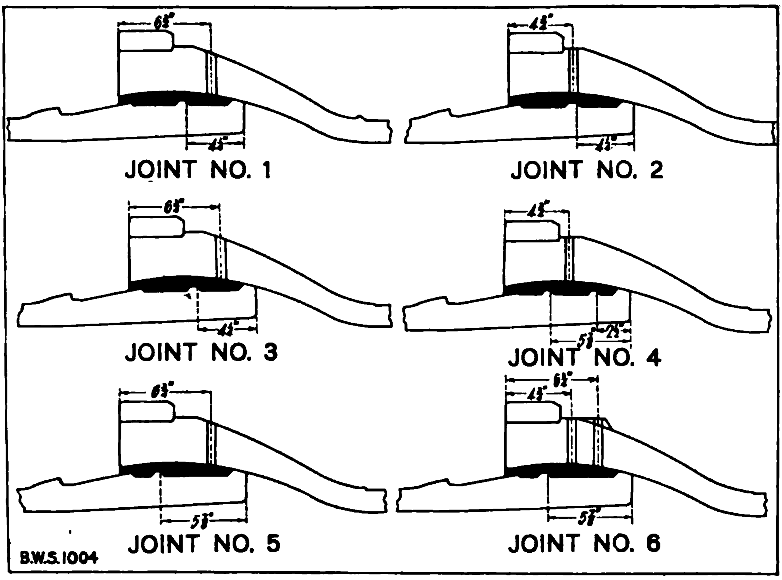
Experiments conducted before settling upon the contract design were therefore repeated with the improvements hereinafter described as to observing the behavior of the lead and as to balancing hydrostatic pressures. In the experiments with the new apparatus, the principle of the joint immediately became evident, as follows: When lead in pellets is forced in through holes in the back of the bell, the spigot end is shoved out of the bell from 1/16 inch to ⅛ inch or more according to the amount of lead injected. The force of the injected lead causes the run lead to be compressed against the front of the bell, making a very water-tight band at this point, exactly as would be occasioned by placing a heavy longitudinal strain on the joint. The lead which is forced into the back of the joint under these conditions does not wholly fill and make water-tight the back of the joint. The band of water-tightness at the front of the joint also is not wide enough to remain

in contact when the joint is deflected. The complete tightness in the preliminary experiments was attributed to the large amount of graphite and grease which filled voids not occupied by lead and to the swelling of the pipe at joint which gives an annular area of 400 square inches outside of the area of the 36-inch pipe, and this area, through hydrostatic pressure, is effective in producing longitudinal pull in the joint, even though the two connected pipes be fitted with sliding bulkheads anchored to each other so as not to exert longitudinal pull on the pipes. The 400 square inches in the circumscribing annular space, under a test pressure of 100 pounds per square inch in the pipes, produce, therefore, a longitudinal pull of 40,000 pounds which is effective in compressing the lead at the face of the joint, making it water-tight in any position in which it may be placed.

In the new tests, a tie-rod was provided with clevis and pin centered at the center of the spherical joint, and the opposite end of the tie attached at first to a set of screw-jacks working against the bulkhead which closed the end of the pipe, and later attached to a piston operating in a cylinder of approximately the same size as the maximum diameter of the spherical joint so as automatically to balance the end pull on the lead in the joint. With the jacking device, the balancing was accomplished by computations of the stretch of the tie-rod and gaging the turn of the screw-jacks, checking the computations by careful caliper measurements to see that the spigot did not move in or out of the joint. Under these balanced conditions, a joint made up with a liberal quantity of graphite and grease showed when repeatedly deflected that the graphite and grease were gradually washed out, leaving the joint somewhat leaky. The possibility of such oscillation during the time when the pipe rests on the laying skidway, and particularly when the joint in question lies for a time at the lower end where the pipe leaves the skidway, was regarded as not too remote for consideration, and the conclusion was reached to leave out graphite and grease so far as possible. The method was developed of rubbing a very thin coat of graphite and grease on the face of the bell before pouring the joint and thereafter using with each pellet of lead only a daub of graphite and grease about the size of a pea.

It was found that a joint of the experimental type could be improved by adding more lead, but the point of tightness was still in a band at the face of the joint caused by the lifting out of the spigot. This solution was unsatisfactory in that the pipe might

move longitudinally at the joint due to changes of temperature. A change of length of 0.04 inch in a 12-foot pipe due to temperature was found not inconceivable with the ranges of temperature existing. Furthermore, due to varying grip of back-fill and varying strength of joints the change in length of several pipes might easily concentrate at one point. It was desired to get the zone of tightness on the great circle or place of largest diameter, so that



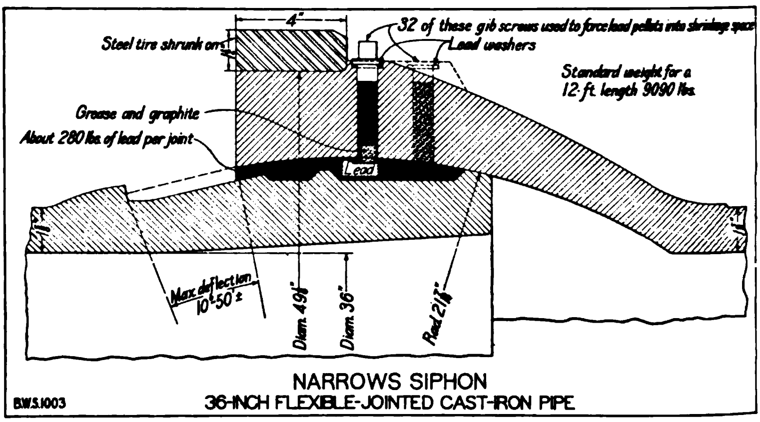
NARROWS SIPHON—Experimental evolution of flexible joint showing progressive locations of gib screws and ridges

in case of a small movement, the joint would act like an expansion joint. In and out movements of about 1/16 inch were tried, and leaks developed in a way which indicated the desirability of tightness at the center.

To accomplish this at first two ridges were tried on the spigot, one on each side of the center line with an idea that the lead might be caused to flow between them around the joint. This proved unsuccessful on account of the great friction which lead has in flowing. The joint was also too rigid, due to the confinement of the compressed lead. The experiment also taught that the good

bearing of lead that is obtained at the front and rear of the joints by injecting lead at the back is an important asset in making the joint rotate on the center of the sphere and not roll out, i. e., a long arc of contact parallel with the axis of the pipe holds the ball in place as would be expected.

The next step was to move the ridge on the spigot toward the front of the joint, so as to leave the center of the joint free for the flow of lead. In the first experiment of this kind, 16 gib-screw holes, still placed toward the back of the joint with the idea that the first effect would be to force out the spigot, and thus



NARROWS SIPHON—Details of adopted flexible joint for 36-inch cast-iron pipe

compress the lead at the face of the joint, and 16 additional holes staggered with the back 16 holes were placed directly over the center of the joint, the bulk of the lead being forced in through these to fill the joint on the great circle. A perfectly satisfactory joint resulted, and an almost equally satisfactory joint resulted when only the 16 rear holes were used. It was at first decided to use this latter design, but on further experimentation the 32 holes were found so superior that they were adopted.

In practice, the quantity of lead to be injected is increased until the joints are filled almost completely over their whole area. In order to improve the flexibility of the joint, a small quantity of graphite and grease is forced in after all the lead has been injected.

Inspection

Contract Cement.—All Portland cement used in construction was inspected and tested, as described in the report for the year 1910. Following is a record for the past five years:

	1910	1911	1912	1913	1914
Barrels tested	1,175,800	1,820,550	1,288,300	1,320,750	1,252,910
Per cent. accepted	95.44	90.31	93.46	96.27	92.54
Per cent. rejected, low strength	1.09	0.43	1.03	...	2.22
Per cent. rejected, lack of increase between 7 and 28 days	0.85	2.15	1.05	0.68	1.71
Per cent. rejected, excess in anhydrous sulphuric acid and magnesia	1.70	4.31	...	...	...
Per cent. rejected, quick-setting	0.74	1.87	1.15	0.24	1.11
Per cent. rejected, falling off in strength	0.18	...	...	2.60	0.19
Per cent. rejected, unsoundness	...	0.60	3.31	...	1.77
Per cent. rejected, coarseness	...	0.33	...	0.21	0.46
Per cent. rejected, all causes	4.56	9.69	6.54	3.73	7.46

Marking Tiles for City Aqueduct.—Two hundred and eighty-seven tiles, 4 inches by 9 inches and ½ inch to ¾ inch thick, were inspected. None were rejected on account of insufficient burning or any other cause. Three per cent. of the tiles was subjected to red-ink test, which consisted in immersing a fragment of tile in red aniline ink for one hour. At the end of this period, the penetration should not exceed ⅛ inch in order to fulfill the requirements of the specifications.

METAL-WORK INSPECTED DURING 1914

	Inspected	Rejected	Shipped
Cast-iron pipe	4,609 tons	291 tons	4,280 tons
Other iron castings	829 tons	84 tons	745 tons
Structural steel	6,861 tons	179 tons	6,682 tons
Reinforcing steel	694 tons	4 tons	690 tons
Steel castings	95 tons	3 tons	92 tons
Cast bronze	1,108 tons	25 tons	993 tons
Rolled bronze	76 tons	5 tons	71 tons
Gates and valves	202	1	201
Copper wire	2 tons	...	2 tons
Lead	1 ton	...	1 ton

Real Estate

For condemnation proceedings, maps were prepared, showing additional substituted routes for relocated highways around Kensico reservoir. The Corporation Counsel was furnished with a general description for advertising purposes and detailed descriptions of each parcel for actual condemnation.

Two parcels of land in the Northern Aqueduct department were acquired from The City through condemnation by the State for state highway purposes. During the year proceedings in the acquisition of two parcels for the straightening of King street within the Kensico Reservoir taking boundary, and the adjustment of the fences were settled and the award paid.

In connection with the construction of the Narrows siphon, a permit was secured from the National Government for the erection of temporary platforms in the harbor. Real estate taking maps were also made for this structure covering an easement at the foot of Arrietta street, Staten Island. These maps were approved by the Board of Water Supply on June 9, adopted by the Board of Estimate and Apportionment on June 12, filed in Richmond county on August 26, and application for the appointment of commissioners of appraisal duly advertised from September 11 to October 24. On technical grounds, the Supreme Court denied the application on December 28.

Eight agreements for telephone or power-line rights-of-way and three leases for quarry or storage privileges were prepared.

STUDY AND DESIGN OF STRUCTURES

Ashokan Reservoir

Olive Bridge Dam.—After due consideration, it was decided not to fill the inspection wells of Olive Bridge dam at this time, because if it should become advisable, clay dumped from the top offered material advantages over the concrete filling originally considered.

Attention was given to minor questions regarding cast-iron piping in the Ashokan aerator and to the cleaning and connecting of the 8-foot steel supply pipes to the Aerator. Preliminary studies were made of the number and location of buildings to be used for maintenance purposes at Ashokan.

Working drawings were completed and issued for several appurtenances for Ashokan Upper gate-chamber, such as galvanized-iron pipe ducts in the chamber walls, screens and gratings for stop-disk wells, checkered steel floor covers, and hangers in the ceiling of the storage space, as well as for platforms, slabs, lintels and other features of the Upper and Lower gate-chambers. The outer slope of the Middle dike near the Lower gate-chamber was slightly steepened to eliminate the retaining-wall formerly contemplated, and a revised section of parapet for Olive Bridge dam was prepared.

Dividing Weir.—In preparing for the construction of Ashokan bridge to connect the highways between the north and south sides of Ashokan reservoir over the Dividing weir between the two basins, alterations were made to the piers built monolithically with the Dividing weir. The purpose of these revisions was two-fold: The piers were lengthened to permit a wider roadway on the bridge while for construction purposes two of the piers were sufficiently reinforced so that, with other provisions, they will permit the construction of this 15-arch bridge in three distinct portions. These piers, as reinforced, will serve as abutments for the series of arch forms used in constructing any one set of five arches. The fifth pier on the north end was sufficiently low to permit adequate reinforcement as a cantilever by the use of embedded bars alone. The tenth pier, however, was so high that it could not best be thus reinforced and a somewhat unique support was devised for the overhanging corner. The top of the pier was reinforced transversely to the bridge axis, to form a cantilever whose fixed end would be the portion firmly founded on the upper part of the Dividing weir. The free end was designed to be supported against the thrust of the steel concreting forms by the assistance of a structural-steel bracing or truss capable of sustaining a thrust at the springing-line of approximately 20,000 pounds per linear foot of half the width of the pier. The design of this support contemplated the use of hanging weights and a toggle or equivalent devices for maintaining the desired thrust of this support against the pier during whatever changes in length of members of this support might be caused by changes in temperature.

Ashokan Bridge (Contract 76).—The design of this bridge, which was described in last year's report, was modified by thickening the face of the arch to make the bridge look more substantial. This modification increased both load and temperature stresses, when the increase of load was greatest and temperature stresses highest, which difficulty was overcome at the haunch, by placing the additional thickness in a separate block on the lower part of the arch.

At the upper part the additional thickness was left monolithic with the remainder of the arch. The space between the cross walls which are over edges of piers was closed with face walls so as to give the effect of extending a massive pier up to the top of the bridge, cartouches were placed on the face of the arch at the crown, and the belt across was decreased in hight to improve the

proportions of mold face of arch so as to make the upper edge overhang. (It was at first desired to slope the face of the arch so as to make the top overhang, but this was shown to be impracticable.)

The attempt to modify the top of the arch by making it elliptical or basket-handle was abandoned late last year on account of available hight being insufficient. An addition of molding at face of arch to make the upper edge overhang required increase in width of piers, but as many of them were already constructed this was accomplished by allowing the tops of the piers to overhang the base, or by cutting the existing concrete in steps for a hight of about five feet so as to make additional concrete nowhere less than one foot thick.

Provision for putting underground all electric conduits in the general vicinity of the Lower gate-chamber was included in this contract. Ducts will lead from the north shore of the reservoir, across Ashokan bridge, through the Dividing Weir gate-house and Upper gate-chamber, along the Dividing weir, thence to the Screen chamber and Gaging chamber. A branch connects the main line of ducts, by way of the Lower gate-chamber, with the highway east of the Aerator.

Power ducts and telephone ducts are separated by 12 inches of concrete, and there is an 8-inch concrete partition in those manholes common to both telephone and power lines, so that the telephone cables will not be subject to electric charges from the power cables. On Ashokan bridge, the telephone and power ducts enter separate manholes. Conduits and manholes were so designed that in case it became necessary for telephone or power companies to cross the reservoir with electric cables in the future, ample room in the underground conduits will be available.

Highway Regulations.—Highway regulations of this and other states were investigated and a set of traffic regulations for the new highways around Ashokan reservoir was prepared, and was adopted by the Board in accordance with Chapter 478 of the Laws of 1914.

Surfacing Highways and Constructing Guard Walls at Ashokan Reservoir (Contract 152).—Specifications for paving with vitrified brick the roads on Olive Bridge dam and the dikes of Ashokan reservoir were begun.

Fences in the Vicinity of Ashokan Reservoir (Contract 143).—Studies were made for a reinforced-concrete guard-rail for the dikes.

Electrical Apparatus, Ashokan Reservoir (*Contract* 161).—Work is nearing completion on plans and specifications for electric motors, automatic controls and wiring for operating the gang-driven valves and sluice-gates in Ashokan Upper and Lower gate-chambers and Dividing Weir gate-house; also electric cables from the switchboard in the Lower gate-chamber to the Upper gate-chamber and Dividing Weir gate-house and the lighting of the Dividing Weir gate-chamber.

As but one motor will operate all valves and gates on the same gang-drive shaft this will be so equipped electrically that it will be impossible to jam a valve or gate against its seat by running the drive shaft in the closing direction when some other valve or gate is already closed. The clutch lever for connecting each mechanism to the drive shaft will be provided with a special contactor which will make contact when the clutch lever is in the operating position, and which will be connected in series with the limit-switch circuit which controls the solenoids in operating the automatic starter for the motor. When a valve or gate reaches the limit of its travel, the limit-switch contact will automatically stop the motor; and it will be necessary to release the clutch lever of the valve last operated before the motor can be operated again in the same direction. Each clutch lever will be provided with an additional electrical contact which will be connected to an indicating lamp on the motor-control panel, so that the operator can tell at a glance which clutch lever must be released before it is possible to start the motor. An ammeter mounted upon the face of each panel will indicate the number of gates which can be operated at a time without overloading the motor.

Kensico Reservoir

Kensico Dam (*Contract* 9).—Plaster model studies of the architectural features of Kensico dam were carried on during the early part of the year. The completed studies in plaster, together with trial stones of granite developed such changes in the shape, projection and width of the rusticated band courses, and changes in the cornice which involved the introduction of a simple decorative frieze course, that a second full-size stone model was started. The satisfactory cutting of these stones and the erection of the models required daily inspection, particularly in the cutting of the frieze stones. Every effort was made to secure extreme coarseness in the various textures required for the work.

The preparation of working drawings for the stone facing of Kensico dam was continued, those for the facing stones of the dam itself being nearly completed. Similar detail drawings for the pools, pavilions, terrace and other architectural features were begun. Computation of the quantities for final estimate of the stone-facing items of this contract was commenced.

Other working drawings were made for various accessory structures of Kensico dam as follows: Floors and roof of Upper gate-chamber; roof, storage rooms and other details at Lower gate-chamber; culvert to replace the portion of stream-control flume under the terrace and pool; storage room at end of upper inspection gallery; roadway on top of dam and the general landscape treatment and drainage of the grounds adjacent to the dam.

Studies were made of the amount of brick paving to be done in the vicinity of Kensico dam, and how much of this should be included in Contract 9; of piping layout for water-supply system at the dam; of the number and location of buildings to be used for maintenance purposes at Kensico, and of superstructures of Kensico Influent and Effluent chambers.

Kensico Bridge (*Contract* 9).—During the year the design of this bridge was resumed. It is a 3-arch highway bridge crossing the small valley which is to be used as a waste channel from Kensico reservoir. Drawings had been hastily furnished in 1912 for cutting stone for this bridge, but no construction work had been done. The arch stresses and dimensions were verified and study was made of the shape of the wing-walls and of the road approaches at each end of the bridge and in connection with the end of the Kensico dam, which adjoins. Study of the bridge resulted in an increase in width of sidewalk and also of that on the dam of which the bridge is architecturally sort of a continuation. The increase in sidewalk width on the dam was made by merely moving the parapet over.

Hill View Reservoir

Working drawings were issued for roads and paths, grading and drainage features, concrete posts and wire fence, for gratings and screens and for the slabs over the shafts in floors of the Uptake and Downtake chambers. Attention was given to various questions of shaping embankment, trimming slopes and grassing. Computations were begun upon which to base a diagram showing the capacity of the reservoir at any elevation of water surface.

Silver Lake Reservoir

Drawings for the gate-chamber and for Richmond conduit, begun in the latter part of 1913, were completed early in the year. Embankment sections were revised by increasing their top widths to provide for future widening of the roadways and paths as suggested by the Department of Parks. Attention was given to details of slope protection, water conduits, valves and their mechanisms, operating shafts, electric-power ducts and sluice-gates.

Catskill Aqueduct

Moodna Siphon Supplementary Shaft and Tunnel (Contract 160).—Hydrostatic tests of the Moodna, Hudson and Breakneck siphons which are actually all part of one continuous pressure tunnel, were made in the spring, as described in the report of Northern Aqueduct department, following.

Considerations and estimates of the proper method of repair show that excavating a new shaft from the bottom of the Moodna tunnel downward for about 400 feet and of a new tunnel connecting this shaft with the Hudson Downtake shaft, bulkheading off and abandoning (except for the purpose of access) the disturbed tunnel and the Downtake shaft for a depth of 400 feet below the tunnel, cost about the same as an alternative scheme for interlining with steel the same length of disturbed tunnel and the 400 feet of shaft. Placing the steel interlining within the present tunnel and shaft would have been less expensive, but would have involved a reduction in the capacity of the tunnel which was not thought desirable.

The scheme for reinforcing the present tunnel was never regarded favorably because the tunnel would still be subject to movement of the hillside in case that was the cause of the disturbance, and because masonry construction was preferable to steel at anything like equal cost.

The designs are similar to those used in previous pressure-tunnel construction. Since it was necessary to continue to use Shaft 7 as an access shaft, there being no other in this vicinity, and since Shaft 7 terminated in a portion of the tunnel which was to be abandoned for conveying the water, it was necessary to place an access door in the plug just east of the supplementary shaft. This plug and access door are similar to the plugs used at drainage shafts in Catskill aqueduct, the main difference being that several pipes are

placed through the plug to serve in the future as conduits for hoisting-ropes, water-pipes, electric wires, etc., in case these are needed at Shaft 7-A.

In the matter of construction plant, much consideration was given to the question whether the upper part of the Hudson Downtake shaft should be opened or not. It was considered that ventilation and hoisting would be made much more convenient, but the cracks in the lining of the shaft at the Moodna tunnel were being successfully calked with lead wire, cutting off the inward flow from the Hudson river, and it was thought that opening the shaft would tap the cracks through which the inflowing water had come, and would thus cause much added expense of pumping and inconvenience which would more than offset the value of opening the shaft. The contract was finally written providing that the contractor might open the shaft if the Engineer could be convinced that his reasons were sound, but that all estimates for payment should be on the basis of the quantities required to construct the work without opening the shaft.

Estimates were made of the probable plant required under Contract 160, and of the power to operate it. Comparative estimates of the cost of furnishing this power by a contractor's steam plant, and by electricity purchased from the Central Hudson Gas & Electric Company were made, and it was shown that the best interests of The City would be served by purchasing electric power from the Central Hudson Gas & Electric Company. A lease was consequently entered into with this company on October 17 for furnishing electric power at a maximum rate of 850 kilowatts at Shaft 7 of Moodna pressure tunnel, for a term of one year from December 15, with rental at the rate of $1,835 per month and energy charge of 1½ cents per kilowatt-hour. In order to get 33,000-volt power to the tunnel shaft it was necessary for the power company to extend its existing lines from St. Andrews along the aqueduct right-of-way.

Hudson Pressure Tunnel (*Contract* 90).—A test of the Hudson full-capacity blow-off was made March 23. The essential features of this blow-off are the blow-off pipe having a minimum diameter of 40 inches and controlled by straightway hydraulic valves, and a stilling chamber 25 feet long and about 10 feet in diameter cut in granite and partly lined with concrete, into which the jet discharges on one side, and from the same side of which

the wide outlet channel extends at right angles. The jet is so directed that the water escaping to the outlet channel has to cross it in traveling to the end of the stilling chamber, this interference being relied on to assist greatly in destroying the approximate 120-feet-per-second velocity with which the jet emerges.

The end shafts of Moodna and Breakneck siphons were practically full, but as there was no storage available north of Moodna siphon, the quantity was insufficient to operate the blow-off for more than a few minutes and rough computations indicated that the maximum discharge was probably not over seven-eighths the maximum which would have taken place with sufficient water stored above Moodna siphon. The valves opened fully without difficulty, taking not more than 30 seconds. The valves chattered from about one-quarter to three-quarters open, but not badly, and no evidence of damage to the seats was apparent. The river level had backed up in the blow-off conduit at about the elevation of the bottom of the stilling chamber and there were about six inches of ice in the river and in the conduit. The depth of water standing in the conduit was about 8½ feet. When the valve was opened the sheet of ice rose in the conduit and at the mouth of the conduit about two or three feet before it broke and the fragments of ice were carried under the floe, leaving a space of open water about 50 feet in radius at the mouth of the conduit. After the ice had broken, the level of the water in the conduit was not much higher than in the river.

Record Drawings.—Work on the preparation of record drawings for Reservoir, Northern Aqueduct and Southern Aqueduct departments was in progress throughout the year, and those for City tunnel were begun.

Turbidity and Color Removal Plant (*Contract* 159).—The assumption has frequently been made, without, however, opportunity to investigate its soundness, that turbidity of Catskill Mountain water as supplied to The City could be avoided by a surface treatment of the clay banks along the Esopus stream which are the main source of the fine turbidity. Active investigation in this matter begun in the early part of the year quickly showed that the conspicuous sources of turbidity on the main Esopus creek were only a few of the sources of turbidity. It was concluded that it was impracticable to treat them so as to prevent objectionable turbidity during certain periods, and also that the danger of turbidity

was great and that the turbidity in the aqueduct was likely to reach 50 parts per million for a few days and 10 parts per million for several weeks as a total during the year. Preliminary drawings for a plant at Hill View reservoir for storing, dissolving and pumping the chemicals, which were to be lime and sulphate of alumina, were therefore made.

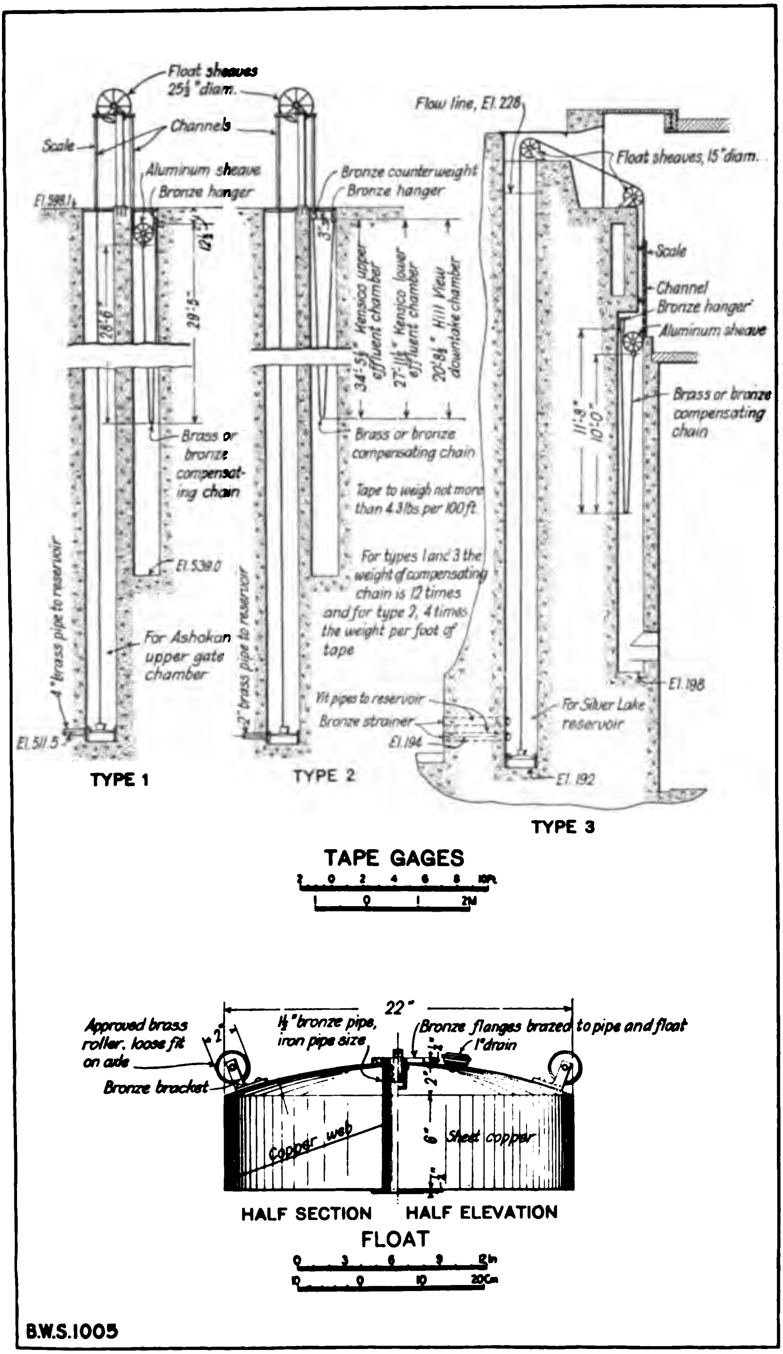
The suggested site and several other sites which had advantages in convenience of freighting chemical and in disposal of sludge from the reservoir were investigated, as were also locations north of Kensico reservoir beginning at the Harlem Railroad siphon and continuing along the line of the aqueduct to and including the land adjacent to the Influent chamber.

The water purification plants at Pittsburg, Cleveland, Toledo, St. Louis, Louisville, Cincinnati and Columbus were examined to observe methods of handling the chemical in connection with this proposed plant and also in connection with filtration studies in general for the Catskill system.

Filtration Studies.—Some consideration was given to the question of the Eastview filter plant, relating to procedure, extent of experimentation required, type of plant, etc. The type of plant is still to be determined.

Gaging Machines (Agreement 90).—Work was resumed in connection with the gaging machines for measuring the flow of water at various points along the aqueduct. The gaging machine consists essentially of an automatic recording device carried by means of an automatic machine which is driven by a gasoline engine, on tracks provided in the floor of the gaging chamber, and which will traverse both horizontally and vertically without assistance from the operator during the gaging process. The machine was designed with complete automatic operation paramount in mind, automatic devices being provided for stopping the machine at the upper and lower limits of the traverses. Its construction is light so that it can easily be transferred from one point to another as desired.

Maintenance of Aqueduct Telephone Line (Agreement J).—The cost of maintenance of the aqueduct telephone system from Ashokan Screen chamber to Croton Lake gate-house, built under Contract 93, was studied and compared with the cost of maintenance by the New York Telephone Company. It was found that the New York Telephone Company could maintain The City's line more cheaply and more efficiently than could The City, and Agreement J was accordingly prepared.



RESERVOIR LEVEL GAGES—Type of float gage to indicate reservoir levels accurately

Venturi Meters.—Arrangements were made with the makers of the Ashokan, Pleasantville and Kensico Venturi-meter recording instruments to substitute for the indicator recorder originally specified a later type of instrument, which also registers the total quantity of water which has passed through the meter from the beginning of service.

Maintenance of Buildings.—Specifications were prepared for white and yellow paint for maintenance of buildings and fences in the Northern Aqueduct department.

Document Building.—Study was given to the location and preliminary design of a document building for permanent storage of all Board of Water Supply records, originally proposed to be located on City property near Kensico dam or the Effluent works. A decision was reached to abandon this location and utilize for the purpose the top floor of the drainage chamber over Shaft 21 of the City tunnel, at Clinton and South streets.

Vents.—A feature affecting the construction of some of the chambers was the necessity of providing for the sudden entrance or exit of large volumes of air from the aqueduct. Rectangular holes of adequate area were left in the cornice stones for this purpose. The openings were hung with bronze flaps light enough to move with a change in air pressure from either side, but normally returning by gravity to their neutral position, which closes the openings. A grating is used in the floor in place of one of the concrete floor slabs, through which air passes to or from the aqueduct. As the bronze flaps are out of direct line of the wind, and as air is not passed through the grating under wind pressure, the flaps will not open except in case of emergency, as intended.

Vent flues for all pipe-siphon chambers and certain areas for vent or intake were provided in the floor of the Kensico Influent, Upper Effluent, Lower Effluent and Screen chambers and the two Hill View chambers.

Appurtenances.—Studies were continued intermittently for the design of the stop shutters, racks, screens and similar apparatus not already provided for, and specifications were begun.

Operation and Maintenance.—Preparation of the set of sheets showing graphically the hydraulics of the principal aqueduct structures was continued. Suggestions were also made of hydraulic experiments to be made in the early stages of aqueduct operation to obtain useful data for future maintenance and operation. Estimates were made of the current likely to be needed for power and lighting for structures near Kensico reservoir and along the aqueduct in Westchester county. A small-scale profile of the aqueduct was prepared, for use of the operating force and others, showing manholes, chambers, changes of grade, etc. Study was made of operation diagrams of the principal aqueduct structures for the information and assistance of the maintenance force. A schedule was prepared of a temporary organization to operate and maintain the aqueduct west of the Hudson river, and an inspection was made of existing buildings on City property in the Northern Aqueduct department to determine their suitability for maintenance purposes.

City Tunnel and Pipe-Lines

Shaft Closures. Experiments on Shrinkage of Concrete.—Further attention was given to several methods of constructing shaft closures to insure stability and water-tightness (see 1913 report), including the question of rough pointing the original shaft lining wherever the gap in this lining in which the concrete closure could be placed directly against the rock was not of liberal hight; also above and below junctions between shafts in rock and shafts in earth to insure anchorage of reinforcing steel. The roughness of the existing concrete lining seemed sufficient and in general pointing was omitted.

The time during which the concrete closure was to be allowed to set before grouting remained a point of discussion and investigation. The specifications for the City tunnel, as for the previous pressure tunnels, called for a three months' wait between the placing of the concrete closure plug and its grouting to the rock. This limit was based on shrinkage experiments recorded in treatises and was intended to be liberal. In practice it was generally very inconvenient to allow so long a time because when the concrete in a closure has been wholly placed it is desired to finish all the remaining work at that shaft.

In order to decide how much of this period was essential an experimental test of shrinkage was made. A block of concrete,

octagonal in shape, 14 feet "across flats" and 3 feet thick, was placed in one of the disused magazines for explosives, consisting of a chamber in the rock adjacent to the tunnel. The concrete block rested on fine muck covered with tar paper to permit unrestrained shrinkage. Five thermometers were placed at various depths ranging from 1½ inches to 13 inches; three near the center of the block and two near the edge. Measurements of diameter were made across the top of the concrete block and at various depths to gage-points on vertical steel rods set around the concrete into holes drilled in the rock. The temperature of the concrete when placed varied from 55 degrees to 60 degrees Fahrenheit at the various thermometers and the maximum temperatures at setting occurred in about two days and varied from about 73 degrees at a thermometer near the outside of the block at a depth of 1½ inches to about 93 degrees at a thermometer near the center at a depth of 13 inches. In about three weeks the temperature at all the thermometers had dropped to about 58 degrees, after which the temperature fell off very gradually to approximately that of the air in the chamber which, except for a rise of three degrees during the last few days of the experiment, remained from the start at about 56 degrees, increasing temporarily about one degree during the period of high-setting temperatures.

The measured changes in diameter of this concrete block varied from 0.02 inch near the bottom to 0.04 inch near the top and followed the temperature changes as nearly as could be expected from the varying conditions of temperature and restraint at different hights in the block and from the necessary inaccuracies in such minute differences in measurement. To the end of the experiment, which lasted about 60 days, there was no evidence of shrinkage apart from that accounted for by reduction in temperature.

The concrete test block, exposed as it was on all sides but the bottom, did not seem a fair criterion for the maximum temperatures that would occur in a deep shaft closure surrounded by rock nor for the slowness with which the temperature would fall. Observations under actual conditions, of the temperatures of the setting concrete until they reached that of the surrounding rock, were therefore made by placing thermopiles in the closures at Shafts 3 and 5. At the former shaft the temperature of the concrete was 115 degrees on the second and third days and fell to 60 degrees in about two weeks. At Shaft 5 the temperature reached 135 degrees in two days and then fell at a gradually decreasing rate,

being 80 degrees at the fourteenth day and 65 degrees at the twenty-seventh day, when observations ceased.

The relatively low maximum temperature and quick falling at Shaft 3 are accounted for by the fact that the shaft contains two 6-foot risers, a 3½-inch drain-pipe and a 4-inch pipe for wires. The thermopile was 3½ and 4 feet respectively from the risers and 2 feet from the small pipes. Shaft 5 contains one 4-foot riser and the thermopile was 2½ feet from that.

The field engineers concluded that one month was a sufficient time for the closures to set before grouting and this was used in general practice.

Changes in Valves and Piping.—The Department of Water Supply, Gas and Electricity was, at the end of 1913, engaged in a systematic study of the use of Catskill water and the connections necessary with the shafts of the City tunnel as well as with the City pipe-lines extending from the Brooklyn shafts. The piping in City Tunnel chambers and the pipe-line connections were being designed on the best information then available.

In the spring of 1914 the results of the study were received and put into effect. A number of 30-inch connections to shafts were changed from present to future installation and vice versa. Pressure regulators were added at Shafts 8 and 9, requiring radical enlargement of the chambers and a re-design of Chamber 9. A connection to the high-pressure fire system was substituted for one of the connections to the general distribution system at each of Shafts 18, 19, 20, 21, 22 and 23. These connections are to be controlled by 20-inch check-valves and 20-inch electrically-operated gate-valves placed in the chambers, the electrically-operated valves being like those already in service at other points on the high-pressure system and, also like them, operable from a distant point, probably one of the high-pressure fire pumping-stations.

Trap-Doors.—As a raised entrance and door are impracticable or undesirable at all but one of the City Tunnel chambers, trap-doors were required and designed for convenient handling by one man if necessary. Each door has, attached to itself, the means for being held open against wind or shock and for convenient placing of barriers to prevent people from falling down the stairway. These barriers can be placed without leaving the opening unguarded to obtain them. Hinges are flush with the ground and padlocks are protected from dirt and wet.

Stairs, Gratings and Railings in City Tunnel Chambers.—The designs have been developed and drawings for many of the chambers issued. Stairways for access to chambers have theoretical treads of about 6 inches, a rise of about 10 inches, a width of 22 inches between stringers and a clear width of 23½ ± inches between railings. The stringers are 6-inch 8-pound channels with 1½-inch by 1½-inch by ¼-inch angles riveted to them for support of treads. The treads are of pressed triangular pattern steel plate ¼ inch in minimum thickness. These plates 12 ± inches wide are bent up 1½ inches in the rear and down 1¾ inches at the nose, leaving 8¾ inches for the tread proper. Treads are attached to angles on stringers by ⅜-inch stove bolts.

A deck, similar to those in engine rooms of steamboats, consisting of steel gratings supported above the piping and covering a certain part of the total chamber area, will permit convenient access to all valves and Venturi-meter registers without climbing over pipes. Gratings are in panels for convenient removal in case better access is required to piping, and are constructed of 1¼-inch by ¼-inch steel bars set on edge 1¼ inches apart on centers and held in place by two ⅜-inch bolts and a line of ⅜-inch pipe separators. Gratings are supported on 3-inch 5.5-pound or 7.5-pound I-beams supported on angle iron wall brackets and 3-inch I-beam posts; also in part on 3-inch channels bolted to walls.

Railings are of standard 1¼-inch steel pipe with screw ball fittings. Posts are of same size and in general are screwed into special cast-steel base sockets which are bolted to the webs of I-beams supporting gratings or to stair stringers. At tops of stairways and at some other places railings are supported by wall flanges.

All stairs, gratings and railings with bolts are to be galvanized by hot dipping done after parts are assembled to the greatest extent consistent with reasonably convenient erection in the chambers. Electro-galvanizing was investigated with an idea of using it for threaded articles, but it was found much inferior unless the process is continued several times as long as is usual. It was also decided that firmer construction would result without a cushion of zinc in the threads. Rusting of threads will be avoided so far as practicable by having pipe threads cut so as to be covered by the fittings as much as practicable and having bolts not longer than required.

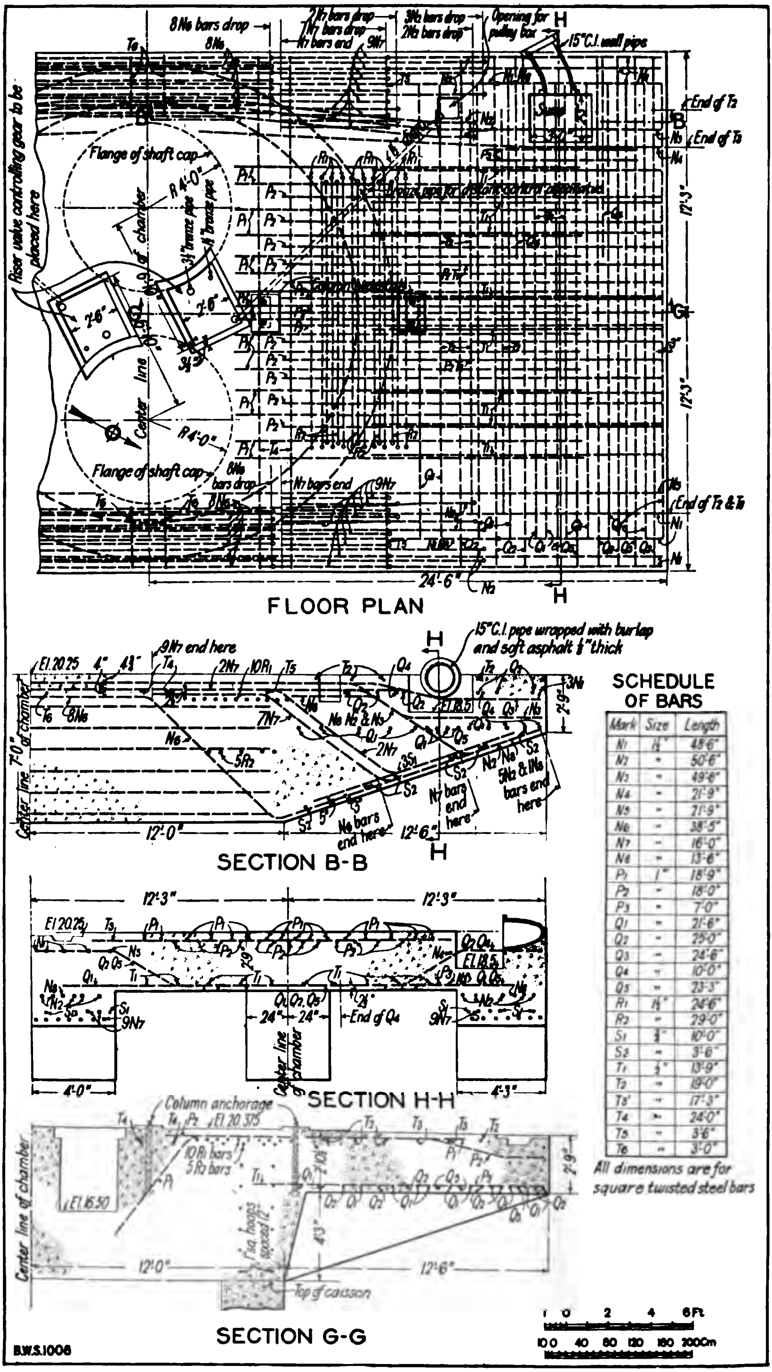
Reinforced-Concrete Cantilever Foundations for Chambers at Shafts 7 and 20.—Chambers at Shafts 7, 19, 20, 22, 23 and 24 are entirely supported on the shafts in earth. As these shafts are much smaller in area than the chambers the resulting overhangs are deepened in parts to form cantilever beams, between which the shallower parts form the connecting floor of the chamber. This type of design worked out with reasonable simplicity, considering the heavy loads to be carried, except in the case of Shaft 20, and in lesser degree, of Shaft 7.

Shaft 20, containing two 48-inch risers, is 19 feet 4 inches in external diameter. The chamber is designed to contain connection piping consisting of two lines of 30-inch valves and pipes with cross-over connections and by-passes for 16-inch pressure regulators on each. The outside width of chamber is 27 feet 8 inches and the outside length 42 feet 6 inches which results in large overhangs beyond the circular shaft which does not furnish a good bearing for cross-beams widely separated.

Conditions at Shaft 20 were further complicated by shallow main sewers, requiring a high floor in order to permit drainage into the sewer, resulting in a thin roof to get headroom, and finally columns inside the chamber to divide the spans of the shallow roof beams. The automatic controlling apparatus for the riser valves required pits in the floor which would be objectionably inaccessible if placed between the risers near the columns. Hence the pits had to be placed between the risers and side walls of chamber, in which position they cut across the only space in which the heavy reinforcement could have been placed to reinforce floor cantilevers resting on the shaft caisson. Thus pushed off the caisson, the side cantilevers are instead supported on a quadrangular system of ties circumscribing the top of the caisson and connected with the top of the caisson by four triangular concrete brackets or struts extending from the corners of the quadrangle of ties to the sides of the caisson.

The system is of course masked by the concrete surrounding the ties which forms a part of the cantilevers and partially contains the struts. The struts are blocks of concrete and, though conceived of as struts acting diagonally, are subject to shear acting vertically and to complementary diagonal tensions. It is these tensions which really cause the complication since they require a mass of diagonal steel in loops which interlace with the cantilever steel and quadrangular ties. The chamber floor being so wide, a

SHEET 5



SCHEDULE OF BARS

Mark	Size	Length
N1	1¼"	48'-6"
N2	"	50'-6"
N3	"	49'-6"
N4	"	21'-9"
N5	"	21'-9"
N6	"	38'-5"
N7	"	16'-0"
N8	"	13'-6"
P1	1"	18'-9"
P2	"	18'-0"
P3	"	7'-0"
Q1	"	21'-6"
Q2	"	25'-0"
Q3	"	24'-6"
Q4	"	10'-0"
Q5	"	23'-3"
R1	1¼"	24'-6"
R2	"	29'-0"
S1	¾"	10'-0"
S2	"	3'-6"
T1	½"	13'-9"
T2	"	19'-0"
T3	"	17'-3"
T4	"	24'-0"
T5	"	3'-6"
T6	"	3'-0"

All dimensions are for square twisted steel bars

CITY TUNNEL—Chamber at Shaft 20. Details of floor supported by concrete shaft caisson

middle cantilever is required. Steel for this is carried over the center of the shaft.

Under load the quadrangular system and the middle cantilevers all tend to rotate downward around the edge of the caisson and to bow up over the interior of the shaft. This action would tend to bring the two steel risers into play as ties to hold the cantilevers down. A very indeterminate condition of stress would result. Approximate computations showed the resulting stresses in the risers to be objectionable in magnitude. Joints of separation were therefore devised so that the central core of concrete around the risers could be placed separately and kept free from the cantilevers.

Conditions at Shaft 7 were much less complicated than at Shaft 20, but were inconvenient and resulted in some complications in the interlacing of shear reinforcing steel in intersecting floor cantilevers. The main cause of inconvenience was the eccentricity of the chamber with respect to the shaft, made to better accommodate the piping in the chamber with respect to the riser at which the piping begins and with respect to the direction of the piping in the street. This eccentricity was reduced so far as possible by placing the riser eccentrically in the shaft. Another complication was the extension on one side of the chamber to accommodate a special blow-off valve from the riser designed to drain as much as possible of the northern drainage section of City tunnel into the Harlem river.

Chamber at Shaft 21.—The area available for this chamber was insufficient, requiring the utilization of a second story in order to compensate for the lack of floor space on the ground floor. The first and second stories of the superstructure will each have to be high enough to take traveling cranes and the first story will require additional hight if a jib crane is used for handling the discharge pipes from the unwatering pumps. These first two stories together would require a superstructure at least 65 feet high. At the time that the contract drawings were made, foundations were indicated sufficient for a 12-story building with the idea that the site might be thus utilized to advantage. During the year, it was finally decided not to make provisions for a 12-story building, but merely for one story in addition to the two required for the drainage operations, making the total hight of the superstructure about 80 feet.

Wall caissons surrounding the building site were placed with their outer edges from 6 inches to 10 inches inside the property

line. The chamber and its superstructure are to have walls with outside faces on the property line except where the chamber extends under the sidewalk on the Clinton Street side to accommodate the pipes and valves connecting with the riser. It is apparent that the wall caissons will not extend entirely under the chamber walls and as the latter are generally about two feet thick and the wall caissons over five feet thick, much of the loading will be eccentric.

Structural-steel cantilever girders for this purpose were originally provided, but would have required a general leveling of the wall caissons to below the bottom of the chamber in order that the girders would not project above its invert. These wall caissons extend to ground-water level to keep out the water. By additional reinforcement the invert slab was designed to act as a cantilever, and the structural-steel girders were dispensed with.

Riser-Valve Controlling Apparatus (*Contract* 147).—The drawings for remote controls for all the shaft chambers of the City tunnel including work within the chambers and without, were made. A description of the control proper is in last year's report.

The essential features of this apparatus are a remote control box containing an operating lever and an indicator; the lever for the purpose of causing the riser valves to close, and the indicator for the purpose of showing the travel of the valve, and its position while in the act of closing. These are connected to the controlling apparatus within the chamber by means of mechanical telegraphs running through 6-inch cast-iron pipes embedded in concrete, changes of direction being made by brass sheaves, suitably supported and so located that access to them can be had from the chambers, or from the street. In the case of a break in a water-pipe all that will be necessary to shut off the riser will be to unlock the remote control box and pull the lever.

Operating Equipment for City Tunnel Valves (*Contract* 154).—Drawings of the pipe systems supplying the turbines for various gate and controlling valves in each valve-chamber of the City tunnel were made. In laying out this work it was endeavored to obtain maximum utility and accessibility. The piping proposed for this work will be copper tubing of various gages and sizes according to the needs and requirements. All flanges will be of brazing metal, so that they can be fused to the pipes. Valves will be bronze, and all fittings will be gun-metal.

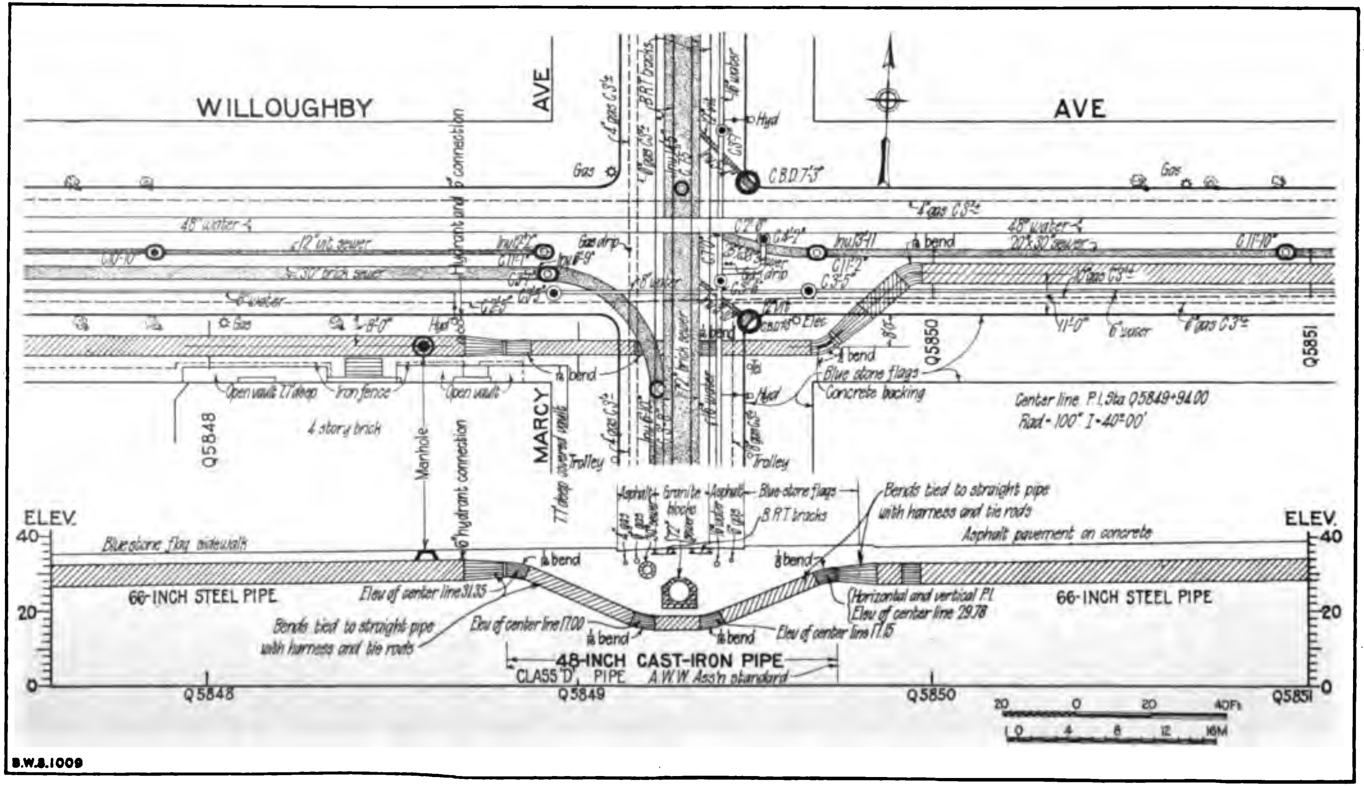
Studies were also made showing position of the electrical conduits in the walls of the substructures in all City Tunnel chambers

in which electrically-operated fire valves are to be installed. The locations of the various electrical equipments were indicated on the drawings in order to be assured that there will be plenty of room to install all the necessary electrical apparatus. The conduits were installed in the walls nearest the mains of the power company, so that the power and control circuits can easily be brought into the various chambers. The automatic starters and control wire for motors of fire valves will be furnished and installed by the Department of Water Supply, Gas and Electricity.

Part of Queens Conduit, 66-*Inch Steel Pipe* (*Contract* 86).—Previous to the preparation of this contract it had been contemplated that possibly the results of tests of various brands of alloyed or particularly pure iron would indicate their superiority to the basic open-hearth flange steel used in preceding pipe contracts. Inspection was made of a large number of metal plates of various kinds which had been subjected to the test described in 1913 annual report, and had been cleaned for final examination. There was no superiority evident for any kind of metal whether pickled or not, except that wrought-iron plates that had been pickled were damaged by exposure of the fibre. By weight the large test-plates of copper steel appeared to have corroded the least, but in the small-size tests it had corroded the most. The conclusion was that basic open-hearth steel, such as has been used in all previous pipe contracts of the Board of Water Supply, is as good as any other material.

Contract 86 was made experimental with respect to pipe coatings. The regular contract items provide for not only the usual mineral rubber pipe coating, but also for one-layer and two-layer coatings of burlap soaked in mineral rubber pipe coating, bitumastic solution and enamel coating; coating consisting of three coats of bitumastic solution alone; and painting one or two 30-foot lengths of pipe with any kinds of paint directed. With the exception of the last-mentioned painting experiments all of the experimental coatings have been applied to 1,000 feet or more of pipe. The following kinds of paint were experimented with, each kind being applied to a stretch of about nine feet of pipe: Elaterite; Everjet elastic paint made by Barrett Manufacturing Company; Tockolith (first coat) and "RIW" (second coat); Detroit Graphite paint No. 501 (first coat), No. 106 (inside final coat) and No. 30 (outside final coat); inhibitor paint consisting of 85 per cent. iron oxide and 15 per cent. zinc oxide ground in pure raw linseed-oil and containing the purest turpentine or benzine and liquid dryer; red-lead paint made with ordinary red lead

SHEET 6



CITY PIPE-LINES— Subsurface conditions at Willoughby avenue and Marcy avenue and method employed in crossing a 6-foot sewer

containing about 80 per cent. of true red lead and mixed with pure linseed-oil with specially pure dryer; Dutch Boy red-lead paste and Dutch Boy linseed-oil containing only the purest of dryer made in accordance with the United States Government specifications. The Dutch Boy red lead and oil were made by the National Lead Company, the red lead being guaranteed 98 per cent. pure red lead.

It will be noted that these include certain well-known proprietary paints, two kinds of red-lead paints and a special iron-oxide paint. The red-lead and iron-oxide paints were designed specially to test the inhibitor theory which has been discussed from time to time by paint experts since first propounded and which has a well-defined following among manufacturers and users of paint. The iron and zinc-oxide paint and the common red lead, which contains about 20 per cent. of litharge, are both supposed to be inhibitors, while the Dutch Boy paint is supposed to be inert because its lead is almost entirely in the fully oxidized form.

These experiments were carried out as planned and the result can only be determined by further inspections from time to time during a long period of years.

Certain makers of welded pipe undertook to compete with riveted and lock-bar pipes under the terms of the contract which after discussion were retained in the old form of not permitting any decrease in thickness on account of supposed superior efficiency of the welded joints. It seemed proper to consider that in a growing community extra capacity becomes available only through deferring additional pipes and that the "present value" of greater capacity may be little or nothing. The only logical way would be to estimate a slightly smaller pipe of smooth construction, but it is difficult to predict in any case how the corrosion and tuberculation are to take place and whether the smooth pipe will in the particular case actually have a greater capacity in the long run though in the average of cases it doubtless has. The welded pipe, while apparently rather close to a competitive basis, was not quite cheap enough to figure among the low bids.

At three of the avenues crossed by the pipe heavy 48-inch cast-iron pipe was substituted for the steel pipe and carried deeply below large sewers and the various other pipes in the cross street.

The other features of Contract 86 were very similar to those of Contract 87, including the Venturi meter near the tunnel uptake shaft and the various connections to the distribution system with masonry chambers around the more important valves.

Richmond Conduit (*Contract* 88).—The work included in Contract 88 is a 48-inch cast-iron pipe-line extending from the terminus of the Narrows siphon to the pressure conduit leading into Silver Lake reservoir. Various branches and valves were placed as usual to permit the Department of Water Supply, Gas and Electricity to make connections to the distribution system.

The main problem in this contract was with respect to the design and, particularly, thickness of the pipe. Hitherto specifications called for pipes of the New England Water Works standard, but since it was found that the thickness of the bells in that standard for the heavier pipes is actually less than the thickness in the barrel of the pipe, special design of bells was used for the heavier pipe. To provide for bells of adequate thickness it was decided to adopt throughout this contract the standards of the American Water Works Association, which were the same as those of the Foundrymen's Association and the American Society for Testing Materials.

Portions of the line have at present or will have in the future considerably more than the normal cover of earth. A similar situation occurred on a portion of the Queens conduit, where the pipe was laid with a maximum of 16 feet excess cover on account of expected future improvements in the street requiring heavy cutting. In that location the thickness of the pipe was increased by 0.3 inch beyond that required by the ordinary rule for existing water pressure, the resulting thickness being 1.85 inches. The 48-inch cast-iron pipes substituted for the steel pipes crossing under certain avenues in the work under Contract 86, previously described, were laid up to about 13 feet deeper than normal and were made of Class D American Water Works Association standard, 1.96 inches thick.

The extra cover over the Richmond Conduit pipe was not so great, but on much of the line there were several feet of extra filling and a complete canvass, so far as possible, was made of New York City cast-iron pipes which had failed under unusual cover and some cases also in the Metropolitan Water Works of Massachusetts were recalled. The opinion of engineers of the Department of Water Supply, Gas and Electricity was that the breaks investigated were due rather to poor foundation than to extra fill, and many cases were recalled in pipe-line laying in Massachusetts where pipes of ordinary thickness were used with fills of seven feet or so. It was finally concluded not to increase the thickness of the pipe in Contract 88 on account of fills of seven feet and the division

line between classes was therefore made substantially in accordance with the requirements for hydrostatic pressure with the usual allowance for water-ram and a stress of 3,300 pounds per square inch on a thickness 0.25 inch less than the actual to allow for rust.

Narrows Siphon (*Contract* 99).—Between the lowest bid, that of the Merritt & Chapman Derrick & Wrecking Co., and the second bid, that of the O'Rourke Engineering Construction Co., there was a difference of only about $1,250 in a total bid of nearly $1,000,000. The O'Rourke company immediately proposed to substitute under a clause of the contract intended to permit alternative types of submarine pipe, a shield-driven tunnel containing a 3-foot steel pipe. The tunnel was to be built of patent recessed concrete blocks one foot thick bolted together with longitudinal rods, the design being similar to the tunnel under construction by the O'Rourke company at Mt. Royal, Montreal. The O'Rourke company offered to build a tunnel six feet in internal diameter at the same price as the company's bid or one seven feet in diameter for five per cent. additional. A shield-driven tunnel had been considered briefly during the early studies for the Narrows crossing, but dismissed on account of the supposed long time to construct. Mr. O'Rourke thought he could make a speed of 18 feet per day from each of two headings which would complete the tunnel in ample time. Considerable study was given to the proposition, both by the designing and consulting engineers. A 6-foot tunnel was deemed too small and the proposition was rejected as being unsatisfactory in its original form, requiring considerable additional expense to be acceptable, and involving new bids, delay in starting the work and injustice to the successful bidder on the contract design.

A check-valve was placed in the line on the Staten Island shore to prevent Silver Lake reservoir from being emptied in case of a break in the submerged pipe. The several commercial types of 36-inch cast-iron check-valve were investigated, evidence being sought and computations made as to their strength. In all of the designs, the stresses in cast iron appeared excessive for the comparatively high head to exist. The most compact design submitted was selected and cast steel substituted for cast iron. This check-valve is included in a modification of Contract 104.

WORKING DRAWINGS

Eleven Superstructures (*Contract* 118).—The drawings for Contract 118, comprising the superstructures for the Sprout Brook,

Peekskill, Hunters Brook, Turkey Mountain and Harlem Railroad siphons, north and south chambers, and the Croton Gaging chamber, were prepared and issued. In these buildings paving-brick culls were again used for the outside walls as they are a very economical building material when used in large quantities. A 1-inch mortar joint was specified, which, with the concrete-stone trimming, gives a very satisfactory appearance to the buildings.

The siphon chambers and the Gaging chamber in this contract are very similar to buildings in Contract 117, with the exception that some are to be built on a high rusticated base already constructed. Where this base occurs a wrought-iron railing will be erected around its outer edge as part of the superstructure contract.

Six Superstructures (*Contract* 123).—The buildings of this contract, comprising the Influent, Upper and Lower Effluent and Screen chambers at Kensico reservoir, and the Kensico north and south siphon chambers, the latter in Kensico cemetery, are to be faced with concrete-stone.

The necessity for a workshop in the Lower Effluent chamber as well as office and toilet-rooms, with a rest room for the engineer in charge in case he is required to stay in the building during an extended emergency period, required the erection within the superstructure of interior structures of one and two stories. Structural shapes with mortar on expanded metal were used for the walls and reinforced concrete for floors and ceilings.

The Kensico Lower Effluent chamber was designed for a decked roof on account of the great width of the building, as a ridge roof of the type in previous buildings would have reached to a disproportionate hight. The deck or flattened portion of the roof over the central part of the building was provided with a minimum slope. It is of reinforced-concrete slabs supported by the horizontal steelwork of the roof framing and overlaid with cinder concrete sloped to the proper pitch and waterproofed.

The main trusses of this building, on account of their considerable load, were supported by steel columns extending through the masonry walls to a footing on the substructure.

Nine Superstructures (*Contract* 124).—The Ashokan buildings were designed and issued as Contract 124. These comprised the twin gate-chambers on the Dividing Weir dike, the Lower gate-chamber, the Screen chamber and the two pairs of siphon chambers at Esopus and Tongore siphons. The latter pair, because of

their remote location, will be of paving brick, resembling the siphon chambers in Contracts 117 and 118. The other buildings will all be faced with concrete-stone, like the parapet of Ashokan bridge, also included in this contract. The bridge is about 1,120 feet long, requiring 2,500 feet of parapet 3½ feet high.

The Upper gate-chambers were designed as duplicates, founded on the substructure in the dike, the roadway along the dike passing between them.

The great hight of the buildings on the water edge combined with the large openings through which to handle the racks over the openings below much complicated the architectural treatment. A balcony runs along the water-front at the roadway level, and affords an opportunity for inspection of operations of the lines of racks, as well as an unequalled view of the magnificent panorama of the new Catskill lake.

The Lower gate-chamber built at the foot of the down-stream face of the Middle dike was set back against the slope, with a berm running behind it, about 10 feet above the floor line. This required a different window design on the rear face, as the building has so little hight, compared with the front where it was desired to use large arched windows for the requisite lighting. The necessity for retaining-walls against the berm at each end of the chamber was met by the design of a curved wall, dropping away with the slope of the dike as it comes to the front.

The chamber also required a 2-story office and a laboratory structure erected inside, one at each end, the former a 3-room and stair unit extending along the front wall from the corner to the doorway, and the latter a 2-room unit with stairs outside and laboratory and locker room upstairs. The latter is lighted by a skylight on account of being in the corner.

The location of this building made it the logical location for the central heating plant, the flue for which therefore became a factor in the design.

The office and laboratory structures are both supported by free standing columns, in order to give a clear floor space to the necessary hight. They will be of structural-steel shapes, reinforced-concrete floors and roofs, and reinforced-mortar partitions, with ample light openings.

The Screen chamber nearby is on a grade so that there is the hight of one story more at the rear than at the front. As the lower level is that of the main floor there is a large entrance to it from

the rear, while a similar doorway at the front opens upon a platform from which material can be handled by the crane and to which access can be had from the main floor by stairs at each side. The few plumbing fixtures are connected to the main sewers built under other contracts.

CONSTRUCTION

Controlling Valves and Appurtenances

Contract 31—Ogden Iron and Steel Manufacturing Company, Contractor

The installation of operating mechanisms for the controlling valves of the Lower gate-chamber of the Ashokan reservoir was completed. Metallic-lined stuffing-boxes for these four valves and scales for the limit switches with a black electro-chemical finish with etched letters filled in with white enamel and lacquered were proposed and furnished by the contractor. In the test of the controlling valves three of them appeared to work satisfactorily, but one gave trouble by requiring too much power. Examination disclosed that corrosion of the steel keys in the guide shoes of the plug caused the latter to bind.

The four valves were then modified by substituting bronze keys for the steel ones, making the clearance greater, by providing a thrust-bearing for carrying the weight of the vertical shafting, and by increasing the bore of all bushings by 1/32 inch as some were found to be corroded to the point of binding. Upon completion of these modifications, the valves operated satisfactorily by hand and later by electric power.

Sluice-Gates, Stop Disks and Operating Mechanisms

Contract 41—Ogden Iron and Steel Manufacturing Company, Contractor

The 5-foot by 15-foot sluice-gate operating mechanisms in the drive shafting in Ashokan Dividing Weir gate-house were installed and given final inspection.

The installation of sluice-gate operating mechanisms and shafting in the Hill View Uptake and Downtake chambers was completed. The principal difficulties encountered were in getting the shafting to run true and the gears to mesh properly and run noiselessly. The shafting was straightened by means of jacks and the gears and stems were rendered noiseless by having them thor-

oughly cleaned and coated with a heavy water-proof graphite grease and then run until they bore evenly.

SLUICE-GATES, GATE-VALVES AND OPERATING MECHANISMS

Contract 42—Coffin Valve Company, Contractor

All of the sluice-gate stands and gate-valve stands complete with operating rods, shafting brackets, clutches, chain-guards and similar accessories in the east side of the Ashokan Upper gate-chamber were installed.

Limit-switch scales on all power-operated valves of this contract were made on brass plate with a chemical black finish, calibrations being etched, filled with white enamel and lacquered. The close of the year found the installation of the valves in this contract completed.

SLUICE-GATES, GATE-VALVES AND OPERATING MECHANISMS

Contract 43—Coffin Valve Company, Contractor

When the electrical apparatus of this contract in the Lower gate-chamber of the Ashokan reservoir was installed, the gates were tested and found to be satisfactory with the exception of minor troubles, which were easily remedied. The limit-switch scales were similar to those furnished under Contract 42.

HYDRO-ELECTRIC POWER EQUIPMENT

Contract 56—L. K. Comstock & Company, Contractor

The power-plant in the Lower gate-chamber at Ashokan reservoir, of approximately 250 kilowatts capacity and consisting of two hydraulic turbo-generator sets with incidental switchboard wiring and other appurtenances, was furnished, inspected, tested, delivered and installed. Turbines are of the Francis scroll type manufactured by Platt Iron Works; the governors by the Lombard Governor Company; the generators and switchboard apparatus by the General Electric Company.

Inspection and acceptance tests were made on the two 125-kilowatt generators built by the General Electric Company, at Madison, Wis. All mechanical requirements of the specifications were met. The following electrical tests were made: Cold resistance, full-load run, hot resistance, overload run, dielectric strength, regulation, sparking and flashing and generator efficiency.

The switchboard and cables required under this contract were inspected, tested and accepted. The insulation of the switchboard

was tested by applying an 1,800-volt alternating current for a period of five minutes, between all conducting parts and frame.

The hydro-electric plant was operated for several days furnishing power for operating tests on all electrically-operated valves in Ashokan Lower gate-chamber. The ease with which the entire plant can be put into operation and shut down was well demonstrated.

Sufficient generator capacity was installed to provide light and power to the Upper, Lower and Dividing Weir gate-chambers, the Screen and Gaging chambers, proposed machine-shop and superintendents' dwellings; also for lighting Dike road and grounds in the vicinity of the Lower gate-chamber, and the switchboard was equipped to serve all of the above.

City Tunnel—Contracts 63, 65, 66 and 67

Setting Riser Valves.—Owing to the physical difficulties under which the setting of riser valves is done, and to the precision required, some of the first valves set were not sufficiently accurately alined. The most difficult part of the work consisted in getting the plug and tripod in proper alinement with the body. After the body was set and made as nearly plumb as conditions permitted, it was grouted in and the steel interlining and concrete placed about it, pockets for tripod feet being left for those valves that have no steel pedestal to receive the wall castings, which are to be bolted to the concrete. A steel setting frame was then placed in the body and carefully alined for concentricity by means of a fine steel wire and gage, the lower end of the frame carrying the tripod. When the tripod was located centrally, it was grouted in place. The platform carried at the bottom of the setting frame was then removed and hung below the tripod by means of suitable castings embedded in the wall. The plug was then carefully cleaned, lowered, rotated in place and locked. The alinement was checked by closing the valve plug upon its seat, and examining the fit by means of a machinist's thickness gage.

Bronze Gate-Valves for City Tunnel

Contract 70—Paul S. Reeves and Co., Contractor

This contract is for furnishing and delivering 94 bronze gate-valves and operating mechanisms for City tunnel.

The greater part of the fabrication in this contract was finished prior to this year.

To overcome the difficulty of forcing lubricating grease beneath the collars of the internal thrust-bearing-type gate-valves, a satisfactory grease jack was designed, which consisted of a jack-screw in a small grease-pot, by means of which pressures up to two or three thousand pounds per square inch can be obtained. This pressure is sufficient to force the grease into bearings under all conditions met.

Bronze Shaft Caps for City Tunnel

Contract 84—*American Manganese Bronze Company, Contractor*

This contract is for the furnishing and delivering of thirty-one 48-inch by 30-inch and 72-inch by 48-inch bronze shaft caps for City tunnel.

The beginning of 1914 found the manufacture of shaft caps well advanced. During the year there were completed and delivered fifteen 48-inch shaft caps, and six 72-inch shaft caps.

Portion of Catskill Aqueduct Telephone System

Contract 93—*New York Telephone Company, Contractor*

This contract was for a portion of the aqueduct telephone system between Ashokan reservoir and Croton Lake gate-house. All work on this contract was completed and final payment made. The line has given satisfactory service during the current year.

Three Steel Floats

Contract 94—*J. Edward Ogden Company, Contractor*

This contract for furnishing and delivering three steel floats, pipe guides and discharge piping for the unwatering equipment at Wallkill, Hudson and Croton Lake siphons was awarded in 1912.

Unfabricated parts of the Hudson, Wallkill and Croton Lake Siphon drainage floats were shipped to their respective points of delivery. All pipe guides, discharge pipes, flange couplings and pump bases were shipped to the Hudson Drainage chamber. The float for the Hudson Drainage chamber was erected and was used in unwatering Moodna-Hudson siphon. The float for unwatering Wallkill siphon is in the course of erection. No work of erection on the float for Croton Lake siphon has yet been done.

All pipe guides, discharge pipe, two manifold pipes, flange couplings and pump bases ordered under this contract were in-

spected, found satisfactory, and are now being used at the Hudson Drainage shaft.

Unwatering of Hudson Pressure Tunnel.—The entire siphon drainage equipment was shipped from the Rondout Drainage chamber to the Hudson Drainage chamber, installed and thoroughly tested. The transformer oil was filtered and dried before filling transformer tanks, and transformer and motor windings were thoroughly dried by electricity before putting into service. Before beginning actual pumping operations, the recording watt-meter and curve-drawing watt-meter were tested and found to be correct. The entire siphon drainage equipment worked satisfactorily and Moodna siphon was completely unwatered without difficulty, and was maintained in an unwatered condition during inspection and repairs by intermittent pumping. It was attempted to unwater the Hudson Drainage shaft, but on account of tight clearances, it was impossible to get the float to pass down the shaft, as the concrete guides became wedged between the steel float guides. In order to remedy the difficulty, it was necessary to bring the float to the surface and cut away sections of the steel float guides. At the second attempt the float was pumped down to within 30 feet of the bottom of the shaft when thrust-bearing trouble was encountered. It was decided that with the marine type of thrust-bearing, the operation of the pumps could not be relied upon as the burning out of this type of bearing frequently occurs, and causes annoyance and delay in getting the pumps back into service. In order to eliminate the bearing trouble, a balanced hydraulic thrust was designed, parts purchased on requisition, installed, tested and operated satisfactorily.

Narrows Siphon

Contract 99—*Merritt & Chapman Derrick & Wrecking Co., Contractor*

Experiments on trial sections of the 36-inch flexible-jointed cast-iron pipe demonstrated the necessity of a very smooth surface in the hemispherical sockets of the pipe bells. Turning in a lathe with cutting tools, followed by either drag cuts or by hand or mechanical buffing was tried. It was found that buffing merely polished the surface and increased its inaccuracies. To overcome this difficulty, wheel grinding was required and drawings were prepared for a lathe attachment which permitted rotation of the stationary

cutting tools and of a revolving grinder, in a plane parallel to the lathe-bed. The machine consisted essentially of a turret rotated through worm-gearing by a variable speed motor, the turret bearing two screw-feed carriages for the cutting tools and a motor-driven grinder with adjustable feed. Machining consisted of two deep cuts with 1½-inch square tools, and a drag cut with a tool of this width but taking only a ⅝-inch cut. A jig on the turret also provided for accurately testing the diameter of the bell socket at any stage of the work. Grinding was done with a coarse, medium-hard carborundum wheel, mounted on the turret and motor-driven through a flexible shaft. During the preliminary work it was discovered that a much smoother surface resulted when the mixture of ground iron and dust was removed from under the wheel by air-blast.

Gate, Controlling and Other Valves and Sluice-Gates

Contract 104—*Coffin Valve Company, Contractor*

Contract 104, for gate-valves, control valves, flap valves, pressure-regulating valves, sluice-gates and appurtenances, was ready for advertising in January. The Coffin Valve Company was the lowest bidder and secured the contract. The equipment purchased under this contract is very similar to that previously designed and purchased, with the exception of the operating mechanisms of some of the gate-valves. The controlling valves which are turbine operated, receive water from the main in the vicinity of the valve. The mechanism consists essentially of a bevel-gear on the main stem of the operating shaft, driven by a pinion which in turn is driven by a worm-gear rotated by means of a double-runner water turbine. Two wheels are furnished for the purpose of running in either direction.

It was decided to build and test a turbine of each size before constructing the others. The turbine for a 30-inch valve was erected on a platform and connected to a hydrant which was on the dead end of a 6-inch water-main about 200 feet long and received water from an 8-inch main. Pressure readings were taken at the hydrant and at the turbine. Torque on the wheel was measured by means of a prony brake with a lever and draw scale, but owing to vibration of the latter approximate readings only could be had. Quantity of water was measured by means of a weir and hook gage, draft tube from the turbine discharged about

four inches above water. Thrust on the wheel was taken by means of ball bearings at each end of the spindle.

Contract 104 *Modification.*—Since Contract 104 was entered into, it developed that some of the valves became unnecessary while others were required in their stead for connecting the City tunnel to the high-pressure fire-mains in The City, and for other purposes. Under a modification of Contract 104 the following valves were eliminated: Five 30-inch gate-valves, thirteen 16-inch gate-valves with flanges and four 6-inch gate-valves with flanges; and these ordered: Six 20-inch electrically-operated cast-iron gate-valves with flanges, six 20-inch cast-iron check-valves, six 4-inch cast-iron screw blow-off valves, one 12-inch gate-valve with hub ends, one 36-inch check-valve and seven hand-wheels and indicators for 16-inch valves.

Working drawings and specifications for all of the above new equipment were prepared and six electric motors for operating the 20-inch fire valves were completed and tested.

Bronze Riser Valves for City Tunnel

Contract 105—*The Exeter Machine Works, Contractor*

This contract was awarded during 1913, and includes the furnishing, delivering and installing of twenty-five 48-inch and six 72-inch bronze riser valves with appurtenances for the City tunnel.

There were delivered during the year six 72-inch riser valves and nineteen 48-inch riser valves.

Valves, Hydraulic Cylinders and Appurtenances

Contract 107—*The Chapman Valve Manufacturing Co., Contractor*

This contract, for the furnishing, delivering and installing of gate and blow-off valves, hydraulic cylinders and appurtenances along Catskill aqueduct, the 40-inch bronze and cast-iron blow-off valves for the Hudson blow-off and the four 54-inch blow-off valves for the Wallkill blow-off, was practically completed during the year.

The cylinder of the 40-inch bronze gate-valve in the Hudson Blow-off connection had been injured during installation, and investigation showed it to be entirely the fault of the contractor, who was ordered to replace it with a new cylinder.

Seven Superstructures

Contract 117—*Michael Staub, Contractor*

This contract is for the erection of seven superstructures for Peak and Wallkill Gaging chambers, Rondout and Wallkill Drainage chambers, Washington Square siphon and Wallkill Blow-off chambers.

The superstructures at the North and South chambers of Washington Square siphon were begun April 15 and were completed at the end of the year except for painting the inside walls and hanging the doors. At Wallkill Blow-off, Gaging and Drainage chambers work was begun June 25. Wallkill Blow-off and Gaging superstructures were carried as nearly to completion as the Washington Square siphon buildings. On account of freezing weather coming early in November and the continued cold weather in December, concrete work for the transformer room and upon the roof trusses of the Wallkill Drainage chamber was ordered discontinued. Rondout Drainage and Peak Gaging superstructures were started during the latter part of August but because of early winter little more than the walls, roof steel, and windows was completed at the end of the year.

The walls of all these buildings are of brick trimmed with synthetic stone. The bricks are paving-brick culls, 3½ inches by 4 inches by 9 inches, the rough, warped side being placed on the outside face. Two-thirds of the headers were made by clipping off the smooth grooved end of the brick, the raw surface presented adding considerable texture and color to the wall. The synthetic stone was of a buff color, tooled in coarse-cut and rough-pointed textures, well in keeping with the rough brick walls.

The cement gun was given a trial on this contract in placing cement mortar on the roof steel. The results were especially satisfactory, as a close contact between the cement mortar and the steel was assured.

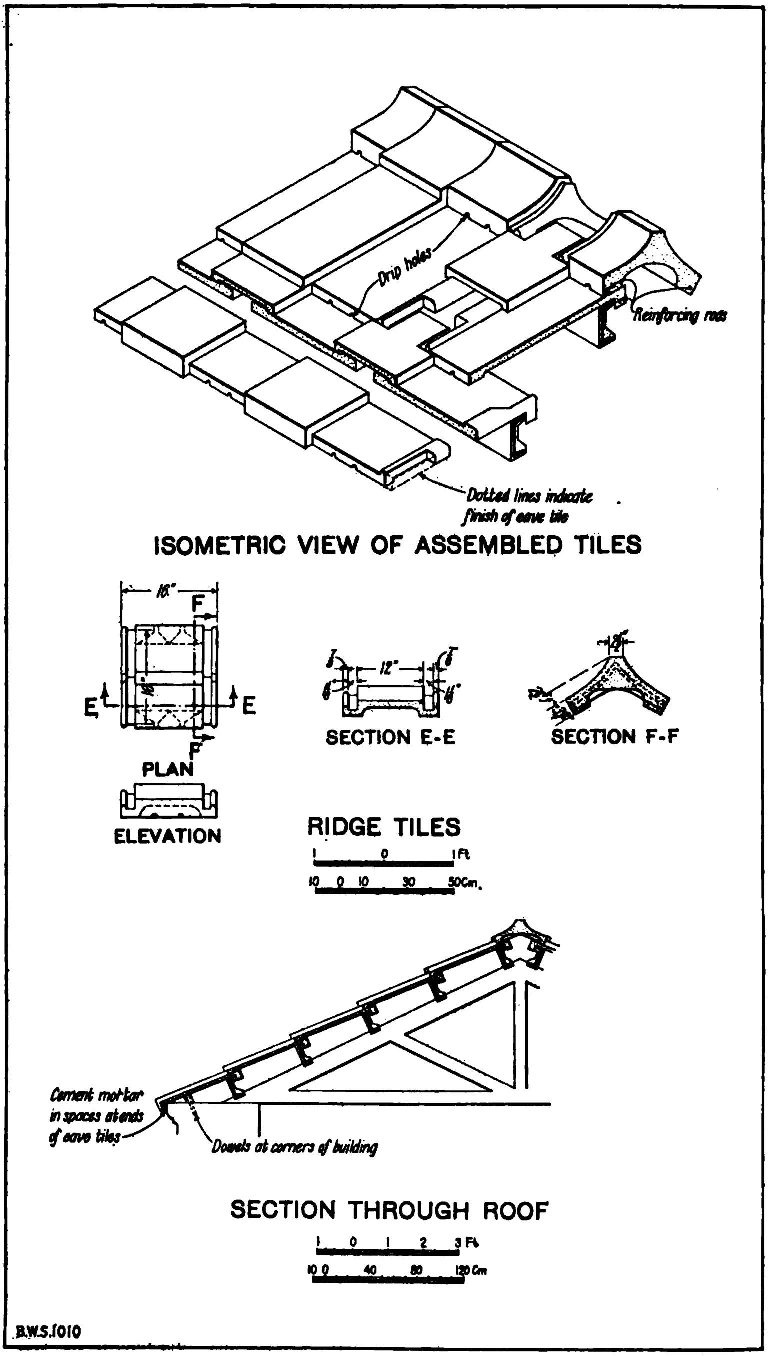
Five Superstructures

Contract 121—*Joseph Balaban Co., Contractor*

This contract is for the erection of five superstructures for Elmsford, Fort Hill and Bryn Mawr siphon chambers.

Work of construction begun during the year was carried about to completion, requiring but the finishing of the mortar covering on the roof steel, and the tooling of the concrete-stone on all five chambers.

SHEET 7



SUPERSTRUCTURES—Details of reinforced-concrete roof tiles and cement mortar encased steel roof trusses

Reinforced-Concrete Roof Tiles

Contract 145—*American Cement Tile Mfg. Co., Contractor*

The American Cement Tile Mfg. Co., who were the only bidders on this contract, had previously constructed a very satisfactory roof for the North chamber of Foundry Brook siphon on requisition, based on the requirements of the old Contract 130, which was rescinded.

The work of roofing the constructed buildings of Contracts 109, 117 and 121 will be done as soon as the weather and the state of completion of the buildings permit after the first of the year. Numerous inspection trips to the shops at Lincoln, N. J., were necessary in order to approve new suggestions and methods of fitting that were brought out as the tiles were made and set up on a model frame in the yards of the shop, and to approve also the colors of the finish and the new mixes and manner of spreading and applying the color.

Portion of Catskill Aqueduct Telephone System

Contract 148—*Lord Electric Co., Contractor*

Plans and specifications were completed for furnishing, erecting and placing in operating condition the portion of the aqueduct telephone system between Croton Lake gate-house and the Hill View Division office. This contract was awarded to the Lord Electric Co. on June 23 and notice to begin work was given on July 1.

All work under this contract was completed, and in a talking test made between Ashokan Screen chamber and Hill View Division office and other intermediate points very distinct speech transmission was obtained.

The contractor failed to complete the work on time and decision is pending as to proper amount of liquidated damages to which The City is entitled under the terms of the contract.

The maintenance of this telephone line and its extension to the Municipal building is described under Agreement M, page 97.

When Kensico Lower Effluent chamber has been completed, it is intended to install an additional trunk circuit between that chamber and the Municipal building so that all stations in vicinity of Kensico reservoir can be called on one circuit, and all stations at Ashokan reservoir and intermediate stations can be called upon the other.

Removal and Re-Erection of Temporary Building

Agreement 84—D'Olier Centrifugal Pump & Machine Co., Contractor

This agreement was for the removal of the temporary superstructure at the Drainage chamber of Rondout pressure tunnel to the Hudson Drainage chamber. The superstructure was taken down during November and December of 1913 and prepared for shipment, shipped to Hudson Drainage chamber and re-erected. A few additions were made to the superstructure to facilitate handling of drainage equipment. All work under this agreement was completed and the chamber made ready to receive the siphon drainage equipment.

Motor-Generator Set

Agreement 85—General Electric Company, Contractor

This agreement includes a 25-kilowatt gasoline-engine generator set and auxiliary equipment furnished by the General Electric Company. All work under this agreement was completed and the set put into operation at the Hudson Drainage chamber in order to furnish direct current for lighting the Drainage shaft and float, and for operating the air-compressor of the siphon drainage equipment.

Motor-Driven Air-Compressor

Agreement 86—Bury Compressor Co., Contractor

This agreement includes a motor-driven air-compressor and auxiliary equipment furnished by the Bury Compressor Co. The specified capacity of the set is 80 cubic feet of free air per minute at 90 pounds pressure or 325 cubic feet of free air per minute at 12½ pounds pressure. All work under this agreement was completed and the compressor put into operation at the Hudson Drainage chamber in order to furnish ventilation to the float of the siphon drainage equipment while unwatering Moodna-Hudson pressure tunnel. The compressor was provided with a 15-horse-power direct-current motor, which was found to be too small to drive the compressor at the required capacity.

As air for ventilation of float of siphon drainage equipment was urgently required, it was decided to purchase a second-hand 30-horse-power motor which could be delivered immediately. After

a rigid electrical test, one was purchased at about half of its original price and sent to the Hudson Drainage chamber where it has operated the compressor satisfactorily ever since it was installed.

Jib Crane for Hudson Drainage Chamber

Agreement 88—J. Edward Ogden Company, Contractor

This agreement is for a jib crane and miscellaneous appurtenances required to handle the discharge pipe of the siphon drainage equipment. All work under this agreement was completed and the jib crane put into operation. After reinforcing certain members, the jib crane gave very satisfactory service. The actual time required to connect a length of pipe to the discharge line of the siphon drainage equipment by means of the jib crane was only 12 minutes, which is very satisfactory when compared to 35 minutes, the time required to do the same amount of work at Rondout Drainage chamber where no jib crane was used.

Maintenance of Catskill Aqueduct Telephone System

Agreement M—New York Telephone Company, Contractor

When Contract 148 for the portion of the aqueduct telephone system from Croton lake to Hill View was completed, it became necessary to supersede Agreement J and enter into a new agreement with the New York Telephone Company for maintaining The City's telephone system as extended between Ashokan reservoir and Hill View Division office. In addition to maintaining the entire aqueduct telephone system under this agreement, the New York Telephone Company leased to The City an underground circuit from Hill View Division office to the switchboard in the Municipal building so that Headquarters offices could call any station on the aqueduct telephone system, and it is also possible for The City to order any telephone construction work at actual cost plus 15 per cent.

The following work was ordered under this agreement: One circuit extension, three wall sets, one connection, one extension and the relocation of one telephone circuit.

CONTRACTS AND AGREEMENTS

Preparation of 12 contracts, aggregating $1,588,000 in value, was completed during the year, and 14 contracts, amounting to $2,668,106.43, were awarded, mainly for Narrows siphon, Queens

and Richmond conduits, Moodna Siphon supplementary shaft and tunnel and various superstructures.

AMOUNTS OF CONTRACTS AWARDED AND VALUE OF WORK DONE

Year	Contract Amounts	Value of Work Done
1906	$79,775.00	$22,983.75
1907	16,912,086.35	228,132.60
1908	9,746,103.67	1,877,789.58
1909	38,233,463.40	7,713,422.82
1910	6,031,795.11	15,600,268.21
1911	22,250,129.41	19,104,290.26
1912	1,359,344.55	19,459,969.70
1913	2,471,850.16	15,053,256.33
1914	2,668,106.43	11,026,494.57
Totals	$99,752,654.08	$90,086,607.82

On account of the comparative unfamiliarity of nurserymen with City work and in view of the experience gained when only one bid, and that one incomplete, was received on Contract AD, for tree transplants, it was deemed advisable to make the form of Contract 156, for furnishing and planting tree transplants at Ashokan and Kensico reservoirs, as simple and as little formidable as possible. In the preparation of this contract, therefore, many of the less important clauses were omitted, shortened or combined, only comparatively essential provisions being included. The forms of acknowledgments, bonds, etc., were also omitted, these being later attached to the pamphlet upon the execution of the contract.

The printing contract, AF, was drafted to cover the work for 1915 and 1916, instead of for one year as heretofore, it being anticipated that a smaller amount of yearly printing would be done hereafter and that better prices could be obtained, as advantage could be taken of the holding-over of type from job to job. This anticipation was fulfilled, unit prices being 10 per cent. lower than for the work under Contract AE for printing during 1914.

Following shortly the approval by the State Conservation Commission of the plan for developing Schoharie watershed, Agreement 95, for test borings in that area, was prepared and awarded.

To provide for connections at the City Tunnel valve-chambers with the high-pressure fire service, an agreement of modification of Contract 104, for eliminating certain valves and providing for others, was prepared and executed.

RESERVOIR DEPARTMENT

George G. Honness, *Department Engineer*

The Reservoir department is charged with the construction of Ashokan reservoir and its appurtenant works, together with various matters relating to the development of the Catskill Mountain watersheds.

ORGANIZATION

Divisions and Employees

The organization remained the same as during last year. The force was increased by the addition of emergency and temporary inspectors in connection with the highway work under Contract 151. H. S. R. McCurdy, Division Engineer, Olive Bridge division, resigned October 14, and J. A. Guttridge, Assistant Engineer, was designated to fill the vacancy. In April, W. D. Hubbard, Assistant Engineer, discontinued his supervision of construction work and was placed in charge of general maintenance and operation of the Headworks.

EMPLOYEES IN RESERVOIR DEPARTMENT—1914

	January 1	December 31	Maximum	Minimum
Engineers and clerks	65	64	94	63
Laborers	58	75	106	53
Gage-keepers	27	29	29	27

EXECUTIVE DIVISION

The work of this division was continued under the supervision of assistant engineers reporting directly to the Department Engineer. L. F. Searle, Assistant Engineer, had charge of the department office and supervised the preparation of construction records and payment estimates of all contracts, necessary plans for various reports, preliminary work and the use of field parties, together with the office routine. S. K. Clapp, Assistant Engineer, supervised construction under Contract 72, for clearing and grubbing Ashokan reservoir, Contract 156, for tree transplants, the sanitary regulations in connection with the various contracts and the hydrographic work. He also supervised the work of the Board's labor forces engaged in the forestry operations, and the individual sanitary treatment at buildings located throughout the Esopus watershed. C. E. Raynor, Assistant Engineer, continued in charge of

construction work on Contract 60, for Hurley dikes, and a part of Contract 151, for surfacing highways, on which latter work he reported to the division engineer of the Real Estate division.

OLIVE BRIDGE DIVISION

J. A. Guttridge, *Acting Division Engineer,* Brown's Station

This division supervised the work under the following construction contracts: 3, for Main dams for the Ashokan reservoir, 10, for Headworks of the Catskill aqueduct, 111, for three concrete bridges, and 76, for Ashokan bridge. Included also were Contract 31, for the control valves, operating mechanisms, etc., Contract 56, for the installation of hydro-electric power equipment, Agreement 85, for modified motor-generator set, Agreement 86, for modified motor-driven air-compressor set, Contract 112, for ladders, gratings, etc., and portions of Contracts 41, 42, 43 and 44, for valves and sluice-gates with appurtenances, Contract 91, for racks, stop shutters, screens, etc., Contract 110, for gaging, metering and other apparatus, and Agreement 87, for stop shutters and other apparatus.

REAL ESTATE DIVISION

Fred K. Betts, *Division Engineer,* Ashokan

The work of this division comprised the engineering features in connection with all real estate matters and the supervision of construction, under Contract 101, District 1, for boundary fences, and Contract 151, for surfacing highways.

OFFICES

The department office was continued at Ashokan as at the end of 1913. The office at West Hurley was discontinued on account of clearing operations under Contract 72, and moved to a building down-stream from the West Hurley dike, this office in turn being discontinued on December 31.

The Olive Bridge division continued to use the same buildings as at the end of last year.

The Real Estate division continued to use the same offices as at the end of 1913 except the two rooms at 293 Wall street, Kingston, which were turned over to the Bureau of Claims on February 28. Several small portable buildings were used as offices by field parties in connection with Contract 151.

At Prattsville an office consisting of two rooms was established in December for preliminary work in Schoharie watershed.

Telephone service over the Board's line constructed under Contract 93 was put in effect and, under Agreement M, arrangements were made with the New York Telephone Company so that in December direct communication was obtained over this line between the Chief Engineer's office and the switchboard in the department office.

PRELIMINARY WORK

Location Surveys

In connection with the development of the Schoharie watershed preliminary work was started in December on real estate and topographic surveys.

Subsurface Investigations

Rondout Watershed.—Work was continued on the wash and core-boring investigations of the subsurface conditions on the Rondout creek. Nine holes were put down aggregating 1,196.6 feet in earth and 106.9 feet in rock.

These borings extended a considerable distance along the creek and confirmed the earlier data that indicated the rock to be at great depths with an overlying strata of water-bearing material which in turn is roofed over with a dense, and probably impervious, clay. The water in the water-bearing sand is under pressure and yields an artesian flow when the "clay roof" is penetrated.

The total amount of boring in the Rondout valley thus far is 38 holes aggregating 4,369 feet in earth and 828 feet in rock.

Schoharie Watershed.—Agreement 95, for borings in this watershed, was awarded to Giles and Clark November 12 and work was begun November 23. Borings were made in the vicinity of Devasego falls on the westerly side of the Schoharie creek on a hill of considerable extent which from surface indications consists of glacial drift of various and irregular strata of clay, sand and gravel.

At the end of the year six borings had been put down aggregating 182.2 feet in earth and 170.9 feet in rock.

In December forces of the Board started boring operations in the same vicinity.

Hydrographic Work

Rainfall.—Rainfall records were in progress at 33 stations, an additional station with a volunteer observer having been established at the foot of High Point on the southerly shore of the West basin.

Stream Flow.—Owing to the closing of the Olive Bridge dam and the control of water through the gate-houses and Waste channel the records of the flow of Esopus and Beaver Kill creeks were obtained at different points than heretofore. These were checked from a combination of the gage hights of the reservoir, the flows through the aqueduct as measured at the Headworks Venturi meter, and the waste through the Beaver Kill waste channel measured by the weirs in the Special aqueduct, and by gage hights in the channel and at the weir established at Winchell falls about 1½ miles below the Headworks. At this last-mentioned place it was possible to obtain a record of all the flows of waste waters from the reservoir as well as the flow from the drainage area above, up to the dam.

The gage at Cold brook, which is about one mile above the upper end of the reservoir, on Esopus creek, was continued. The channel was improved and a new rating curve plotted to be used with the observed gage readings.

During the winter an effort was made to obtain as many actual stream-flow measurements as possible, as it was found that the records of the flow of streams during ice conditions are very unreliable when compared solely with river-gage hights.

Records of stream flow were continued at the permanent stations on the Esopus, Schoharie, Rondout and Catskill creeks. Measurements by current meter were also made during the year to check the rating curves, as follows:

STREAM-FLOW MEASUREMENTS—1914

Stream	Location	Number of Measurements	Range of Stream Flow in Cubic Feet per Second	
			Maximum	Minimum
Esopus creek	Cold brook	11	548.40	13.50
Esopus creek	Winchell falls (pulp mill)	7	96.50	2.78
Esopus creek	Mt. Marion	9	1,010.70	15.50
Rondout creek	Lackawack	5	170.76	17.73
Rondout creek	Rosendale	5	794.06	188.00
Schoharie creek	Prattsville	5	268.40	20.90
Schoharie creek	Gilboa	1	102.90	.....
Schoharie creek	Middleburg	1	145.00	.....
Schoharie creek	Sloansville	1	186.08	.....
Schoharie creek	Esperance	1	196.90	.....
Fox creek	Schoharie	1	3.50	.....
Cobbleskill	Braymansville	1	19.80	.....
Catskill creek	Oak Hill	3	6.56	4.23

PRINCIPAL HYDROGRAPHIC DATA OF THE FOUR CATSKILL WATERSHEDS

	Watershed			
	Esopus	Rondout	Schoharie	Catskill Creek
Area in square miles above gaging station	192	100	236	97
Rainfall, average number of stations...	7	5	4	5
Rainfall, inches	*40.79	*39.31	37.58	35.34
Run-off, inches	27.814	28.34	27.06	24.10
Run-off in billion gallons	92.8	49.3	111.0	40.5
Per cent. of rainfall appearing as run-off	68.2	72.1	72.0	68.2
Equivalent yield per day per square mile in million gallons	1.3	1.4	1.3	1.1
Maximum discharge, date	Mar. 28	Apr. 8	Mar. 28	Mar. 28
Maximum discharge, cubic feet per second	7,050	6,312	9,178	4,900
Minimum discharge, date	Oct. 14	Oct. 8	Oct. 9	Oct. 8-17 and Dec. 19, 29
Minimum discharge, cubic feet per second	8	14	9	1

*Minimum rainfall on the watershed during last nine years (1906-1914)

Turbidity.—Observations of turbidity were taken at Cold brook, at the upper end of the West basin, and at or near the Upper gate-chamber in the West Inlet channel. In addition various studies were made at points on the Esopus creek and tributaries above the reservoir. It was found that the source of a great deal of turbidity was confined to several distinct large eroded clay banks throughout the watershed and two actual mud springs. A laboratory near the Headworks was established under Messrs. Hazen and Fuller, consulting experts. Here numerous turbidities were artificially created and experimented with.

Color.—Color observations were only made in the East basin and ranged from 125 to 155 as determined by the platinum-cobalt disk instrument for field operations. The water of the first flooding was greatly influenced by the vegetation, and the steeping action of the water on the leaves and other growths made a very decided tea color. In order to improve ultimately the impounded waters in the East basin the highly-colored water was drawn off in November in order to expose the reservoir bottom to sunlight and frost, and color observations discontinued.

Thermophone Records.—Observations were made on the temperature conditions existing in the water of the West basin. These observations were taken at various depths at established stations: One just above the Olive Bridge dam in the deepest water and another about a mile further up-stream. Records were obtained at intervals of several days and it was found that during the summer the temperature varied considerably at different depths. As cold weather approached the temperature became more uniform and finally approached a stage when the surface-water was chilled to a greater degree than at the bottom.

CONSTRUCTION

Executive Division

HURLEY DIKES

Contract 60—MacArthur Brothers Company, Contractor

This contract is for the construction of the Glenford, Woodstock and West Hurley dikes, 1.6 miles long, at the easterly end of the Ashokan reservoir.

At the beginning of the year about 83 per cent. of the contract, as measured by the partial estimates, was completed. The work was completed October 31, the final estimate amounting to $806,898.70.

The average force employed on this contract during the working season was 50 men and 10 animals, with a maximum of 92 men and 15 animals.

The living accommodations for the men were continued as last year.

Portions of the plant were discontinued as parts of the work were completed.

The only work on Glenford and Woodstock dikes was caring for the grassing on the finished slopes.

At West Hurley dike the work consisted in paving the up-stream slope, placing the rock fill on the down-stream slope and placing the earth cover on the slopes to be seeded.

The rock paving was obtained from the same quarry as last year and hauled to the dike by train. After dumping on the sides of the dike the material was placed by hand. Work was continued throughout the winter and completed early in the year.

Material for the rock fill was obtained and placed as described last year.

Material for the earth cover on the slopes to be seeded was obtained from the borrow-pit up-stream from the southerly end and handled by the same outfit as the rock except the spreading on the slopes, which was done by team scrapers, harrows and rakes. The entire down-stream slope and portions of the up-stream slope above the paving were seeded with an approved mixture of grass seeds. Some of the slopes were seeded in the spring and these slopes were well cared for during the summer. Other slopes were not seeded until late in the summer so that an acceptable stand of grass was not secured until October.

Of the principal items of the contract the total quantities executed were as follows: Clearing and stripping, 34 acres; excavation, 38,837 cubic yards; embankment, 844,513 cubic yards; surface dressing, 50,463 cubic yards; paving, 24,092 cubic yards; concrete, 34,434 cubic yards, and cement, 36,073 barrels.

CLEARING AND GRUBBING ASHOKAN RESERVOIR

Contract 72—J. F. Cogan Company, Contractors

This contract is for clearing and grubbing the basins of the Ashokan reservoir preparatory to flooding. Work at the beginning of the year was about 55 per cent. completed, as measured by the partial estimates for payment. The contract was completed October 24, the final estimate totaling $383,472.90.

The entire area to be flooded or reached by waves has been cleared. A marginal strip extending approximately for 15 feet below and 5 feet above the normal flow line, and some swamp areas containing an objectionable growth of vegetation, have been grubbed as well as cleared.

The average force employed on this contract was 134 men and 14 animals, with a maximum of 210 men and 25 animals. The working season was from the beginning of the year up to the completion of the contract.

The camp established last year in the vicinity of Ashton was maintained and at the end of the work all buildings which had been used for camp purposes were burned and the surroundings well cleaned.

The plant previously in use was continued at the beginning of the year and various portions of the same were discontinued as the work was completed.

In order to keep down as much as possible the second growth of vegetation in the lower areas of the East basin a 6-foot dike, about 200 feet long, was built on the abandoned Ashton Dike site, after which the easterly portion of the basin was flooded up to Elevation 530. Another dike across the Beaver kill just up-stream from the Middle dike was built which allowed the westerly portion of the East basin to be flooded to Elevation 515.

At the end of the season, so as to have the second growth above these flooded areas as small as possible at the time of the anticipated flooding of this basin next year, all the cleared area between Elevations 515 and 550 was given a second cutting.

A total of 10,377 acres was cleared, 1,870 acres grubbed and 1,022 cubic yards of material excavated.

TREE TRANSPLANTS

Contract 156—*North-Eastern Forestry Company and Franklin Forestry Company, Contractors*

This contract, for furnishing, delivering and planting tree transplants at the Ashokan and Kensico reservoirs, was awarded April 7, and the first planting was begun April 27. The spring planting was completed May 16 and the fall planting of five days was completed September 15.

The progress on this contract, at the end of the year, as measured by the partial estimates for payment, was 32 per cent.

The average force consisted of 50 men.

The camps consisted of tents with board floors erected near where the planting was to take place. Water was obtained from nearby wells and springs that were well protected. Outhouses were provided with pans and all refuse was burned in approved Woodruff pits.

The force, generally obtained from local sources, was divided into pairs, each pair consisting of a mattock-man and a planter. The two mattock-men proceeded in parallel lines about six feet apart, each making a hole at every two paces (about six feet). The planters followed the mattock-men. Other squads followed in a like manner.

On receipt of the forest trees from the nurseries they were inspected by State officials and then "heeled in" near the areas to be planted and ready for use. They consisted of 3-year and 4-year-old Norway spruce, white pine, Scotch pine and a few red pine transplants.

The results of the planting were very gratifying. Not over 10-per-cent. mortality resulted, even though the season was very hard on transplants owing to extreme drought. The spring planting consisted of about 100 acres below the Beaver Kill dikes and about 106 acres along the northerly shore of the West basin. The fall planting by the same methods was made in one tract of about 22 acres along the northerly shore of the West basin.

Olive Bridge Division

MAIN DAMS, ASHOKAN RESERVOIR

Contract 3—*MacArthur Bros. Co. and Winston & Co., Contractors*

This contract includes the construction of the Olive Bridge dam, Beaver Kill dikes, Dividing and Waste weirs, Upper gate-

chamber and adjacent channels, and the Pressure aqueducts from the Upper gate-chamber to the Lower gate-chamber.

The yearly progress on this contract, as measured by partial estimates for payment, was 7.15 per cent. At the end of the year the work was 92 per cent. completed.

The average force employed on the contract during the working season was 950 men and 84 animals, with a maximum of 1,490 men and 194 animals. The camp on the easterly side of Winchell hill in the vicinity of the Olive Bridge dam was continued in use.

The main power-plant at the Olive Bridge dam was in operation until September 11 when dismantling was begun. This work was completed on October 11, except removing two boilers which remained in service until November 27 for furnishing power for sluicing operations. It thus became necessary to install boilers wherever necessary to supply power for the equipment. Many steam rollers and a few steam shovels were used. A small air-compressor was installed at Yale quarry. Stone for the Class C embankment and for paving along the dike was secured from Yale quarry, delivered by a standard-gage track extending from the quarry to the southerly end of the Main dam; thence along the top of the dam and dikes to the various parts of the work. Two Lidgerwood cableways were in service at the Olive Bridge dam up to October, when the up-stream one was removed. The cableway for work in the vicinity of the Upper gate-chamber was removed April 30. The main mixer and crusher plant at the Olive Bridge dam was removed July 7. The mixer plants at the Lower gate-chamber and Dividing weir were in service practically the entire year, the former being removed in November and the latter in December.

The railroad from the Ulster and Delaware railroad at Ashokan to the vicinity of the Main dams, through the tunnel in the Middle dike, was in service until December 15, when preparations were begun to have the tunnel plugged. The railroad line from Ashokan was then changed so as to climb the up-stream side of the Middle dike and connect with the track system on top of the dikes.

Olive Bridge Dam, Masonry Section.—The remaining work necessary to fill the Esopus Creek stream-control conduit together with the platform and retaining-wall in the gorge at the down-stream toe of the dike was completed, the plant being the same as that previously used. Concrete gutters were cast at the intersection of the cones and the face of the dam below the berm at Elevation 580. The concrete parapet wall on either side of the road-

PROGRESS OF PRINCIPAL ITEMS OF WORK UNDER CONTRACT 3

Item	Unit	1908	1909	1910	1911	1912	1913	1914	Total to December 20, 1914	Total Contract Quantity
Earth excavation	Cubic yard	353,677	290,028	114,378	225,456	382,831	478,484	140,953	1,985,807	2,055,000
Rock excavation	" "	46,758	42,125	118,010	116,826	20,290	91,167	67,250	502,426	425,000
Refill and embankment.....	" "	286,734	854,889	1,386,214	837,597	668,400	1,147,092	871,870	6,052,796	7,055,000
Surface dressing	" "	......	......	2,400	4,500	14,700	2,500	23,100	47,200	210,000
Concrete masonry	" "	15,970	87,289	59,926	41,661	52,861	34,307	14,440	306,454	280,100
Cyclopean masonry	" "	25,270	154,210	188,796	95,824	8,600	23,959	5,626	502,285	530,000
Concrete blocks	" "	200	8,563	26,357	21,325	......	......	450	56,895	64,000
Paving	" "	149	91	36	4,450	4,216	282	37,048	46,272	95,000
Vitrified pipe	Linear foot	11,304	520	1,013	807	2,456	2,057	4,660	22,817	21,500
Clearing	Acre	141.5	8.0	11.5	7.0	......	2.41	......	170.41	200

way along the top of the dam was placed, the concrete being mixed by hand. The tool dressing of this wall, together with the cleaning of the exposed faces of the dam, was in progress at the end of the year.

The placing of the Class D embankment in the Esopus gorge against the up-stream face of the dam through the water was in operation the entire season. Until October this fill was made by dumping material from the top of the dam and from the cableway near the stone-crushing and concrete-mixing plant. This material, consisting of a mixture of fine sand and clay, was excavated by a 70-ton Bucyrus shovel from the borrow-pits west of the old block yard and transported in standard-gage dump-cars, 12 cars to a train, and hauled by a 60-ton locomotive to the top of the dam. Material to be deposited by the cableway was loaded by a steam shovel into iron skips placed on flat-cars which were placed under the cableway. This method was discontinued in October and sluicing was adopted as the method to be used in finishing the work. An 8-inch centrifugal pump was set up near the sand-pit of the old main concrete mixer, with an 8-inch discharge with flexible joints every 40 feet, and supported on a series of rafts, leading into the lake. Water for sluicing was pumped from the reservoir through one 8-inch and three 6-inch pipes, which delivered it to the pit mentioned above. Screens placed at the mixing trough excluded the stones, lumps, sods, etc., the average amount of solid material delivered through the discharge being about 12 per cent. Two boilers furnished steam-power for these pumping operations. Material was obtained from the same borrow-pit and handled in the same manner as previously described. An average of 450 cubic yards per day, with a maximum amount of 900 cubic yards per day, was placed by this method. This work was discontinued at the end of November, and the remaining material for this work was to be hauled by wagon and dropped through holes in the ice.

Observations were continued on the masonry dam to record the changes at the expansion joints and to detect cracks in the masonry. No cracks were observed to have developed. Readings taken this year show the maximum change of opening for any expansion joint to be 0.35 inch. The minimum change was 0.08 inch. The maximum and minimum changes of openings to date are respectively 0.42 inch and 0.08 inch. These readings were taken on bronze plugs set in the masonry on either side of the expansion joints at various elevations in the inspection wells.

Records of the passage of water into the inspection wells through the expansion joints were taken regularly during the year. The greatest quantity for all joints was recorded on March 30 when the water in the West basin was at Elevation 540, and amounted to 82 gallons per minute. The smallest passage of water for all joints was in August, when the water was at Elevation 523, and was measured as 6.1 gallons per minute. The greatest passage through any expansion joint was 32.7 gallons per minute and recorded on March 30. The depositing of Class D embankment (selected fine earth through the water) materially reduced the quantity passing through the expansion joints.

Olive Bridge Dam, North and South Wings.—The North wing was practically completed during the year. Some of the embankment material was obtained from the borrow-pits in the vicinity of Winchell hill, the South Wing borrow-pit and railroad fills in the vicinity of the North wing.

The top-soil was secured by means of steam shovel stripping areas within the basin and hauled in wagons to storage piles upstream from the dike, from where it was hauled to place by standard-gage cars. The paving was completed October 11, except at the toe of the northeast cone.

The South wing was practically completed during the year except for a short section at the southerly end of the dike. Embankment material was obtained from the South Wing and Winchell Hill borrow-pits, the former being served by narrow-gage equipment and the latter by standard-gage. In both pits the material was excavated by 70-ton shovels.

Paving was started in April, beginning at the southerly end of the dike. Stone from Yale quarry was delivered in skips on cars. None but the coarser-grained bluestone was used, some of the stones weighing from three to four tons apiece. As the Class C embankment (rock fill) had not been brought to grade during previous years the remaining quantity was placed at the same time as the paving. Three gangs of pavers were employed, each gang working over a stretch 150 feet long and being served by a guy derrick on top of the dike, an additional derrick being always in position so that there would be no delay while moving derricks. Clayey earth for the slopes was obtained from the South Wing borrow-pit and dumped along the berm at Elevation 580, from where it was worked by hand into place. Top-soil for the dike was obtained from stripping in the vicinity of the South Wing borrow-

pit and from a storage pile near the Southeast cone. This soil was handled by steam shovel and narrow-gage equipment and dumped from the berm at Elevation 580 or the top of the dike. After grading to the proper lines, it was fertilized and seeded.

Lateral drains, catch-basins and gutters were constructed where required.

The progress during the year on the principal items of this portion of the contract was as follows: Excavation, 303 cubic yards; embankment, 168,420 cubic yards; paving, 16,798 cubic yards; surface dressing and grassing, 19,800 cubic yards; concrete, 20 cubic yards; cement, 300 barrels.

Beaver Kill Dikes.—At the West and Middle dikes to Station 58, east of Beaver kill, the gaps left in the core-wall were filled in advance of the work on the embankment and the core-wall was completed December 19, the last stretch being at the southerly end of the West dike.

The rolled embankment on the Beaver Kill dikes was brought to grade on October 23 except a small portion at the southerly end of the West dike. The material used throughout the season was obtained from Temple Hill borrow-pit, just south of the easterly end of the Middle dike. Two 70-ton shovels excavated the material and loaded it into 10-car trains. The total equipment consisted of 12 locomotives and 130 cars.

The method of placing embankment was the same as used in previous years. The West dike was first brought to grade near the southerly end and then worked easterly.

The Dividing Weir dike, between the Beaver Kill dikes and the Upper gate-chamber, was placed first as a puddled bank, the material being obtained from the Dividing Weir excavation and a borrow-pit up-stream therefrom and delivered in wagons.

The Class C embankment (rock fill) was brought to grade just ahead of the clayey earth, the latter of which was obtained from the Lawson pit, miscellaneous cableway-tower fills and excavations in the vicinity of the dike.

Top-soil was secured from storage piles up-stream from the dam as described under North wing and from storage piles at toe of the dike. This soil was loaded by steam shovel into standard-gage dump-cars which operated on the track on top of the dikes, dumping principally at night so as not to interfere with the stone trains on the day shift.

Paving on the West dike was completed and progress made on that on the Middle dike. The methods used were the same as those described for the South wing.

At the Middle dike east of Station 58 and at the Waste weir and Spillway channel, which were practically completed prior to this year, the only work was finishing the ends of the dikes at their junction with Leonard hill.

Beaver Kill Dikes, Railroad Tunnels.—Filling the opening left in the West dike for the operation of the Ulster and Delaware railroad was begun on the up-stream portion in January. A wooden hopper was erected above the end of the vertical 12-inch steel supply pipe which last year had been concreted in with the center plug. Horizontal sections of pipe, extending along the roof of the tunnel, were connected up as needed, fixing the point of discharge wherever desired.

Earth for sluicing, obtained from borrow-pits up-stream from the dam, was a fine, sandy material, mixed with clay. Some stone dust was also used. Standard-gage flat-cars, loaded with skips, brought the material under the aqueduct cableway by which they were raised to the top of the embankment and reloaded one at a time on small narrow-gage flat-cars drawn by dinkey locomotive to a derrick which raised the skip above the hopper into which the material was shoveled by hand.

Water was supplied to the hopper, forming a fluid mass as the earth was shoveled into it. More or less trouble was experienced with this layout due to the vertical drop in the pipe and sluicing operations were therefore started from the up-stream portal end, discontinuing those from the top. An open wooden trough was used to carry the material from the hopper in place of the steel pipe used at first. This method was used satisfactorily until the fill was brought to about four feet below the crown of the arch.

This 4-foot space was later filled with dry packing, the stone being placed carefully by hand. Three 2-inch grout pipes with tees spaced three feet center to center had already been placed along the crown of the arch. These three pipes extended the entire length of the tunnel from center bulkhead to portal plug and were there connected with risers, forming vents for the grouting operations. Tees, however, were used on a pipe only through the bay which that particular pipe was to grout.

In August grouting was begun and carried on continuously

PLATE 2

ASHOKAN RESERVOIR—Dividing weir with foundation piers for Ashokan bridge, looking north. West basin at left, Discharge channel to East basin at right. Contract 3

for about 28 hours. Two mixing tanks had been constructed over the grout pipes at the center plug. Each of them was connected with each of the three grout pipes. Stop-cocks enabled any one or all of the pipes to be shut off. Connection was also made from each of the grout pipes to a compressed-air line. The mixture varied between one part cement to one part sand and one part cement to one-half part sand. A small amount was allowed to run in by gravity and then an air-pressure of 80 pounds was applied. Grout had to be thoroughly mixed or trouble would ensue due to the sand plugging the pipe at the foot of the vertical drop. There were used 3,140 cubic feet of liquid grout.

In December preparations were started to close the tunnel through the Middle dike.

Beaver Kill Dikes, Conduit.—The Beaver Kill conduit continued to take the uninterrupted flow of the Beaver kill until June 6 when a temporary dam made of waste material from the Discharge Channel excavation was constructed to Elevation 525 across the stream a short distance up-stream from the conduit. This permitted flooding the East basin to Elevation 515. At the end of the year steps were being taken to make the permanent closure of this opening through the dike.

East and West Inlet Channels.—The only work on these structures was a small amount of earth and rock excavation early in the season at the easterly end of the East Inlet channel.

Upper Gate-Chamber.—At this structure the work consisted of placing the floor blocks, retaining-walls for the north and south roadway approaches and the concrete-steel roof system which forms the roadway across this chamber. Work was practically completed December 23. Concrete was obtained from the mixer used for the Dividing weir and was passed by derricks to the narrow-gage track on top of the Dividing Weir dike, from where it was taken by flat-cars and dinkey and placed by derricks.

Dividing Weir.—All the remaining work at the Dividing weir was completed during the year except a small amount of tool dressing of exposed concrete surfaces. The work for the season included placing cyclopean and concrete masonry in the weir and Ashokan Bridge piers, which are a part of the weir and concrete masonry in the north abutment and gate-house, face dressing for the latter, excavating earth and rock for the foundations of the above struc-

tures, removing a hill to Elevation 585 on the up-stream side of the weir, placing embankment and paving against the up-stream face of the weir, placing riprap on slopes of the Dividing Weir Gate-house inlet channel, constructing sewer system through the weir and placing top-soil at the bridge abutments.

Excavation and placing of masonry were carried on the same as last year. Embankment material was obtained from excavations contiguous to the work and delivered on the bank in wagons.

Paving along the face of the weir was of two sizes, two feet for the bottom portion and three feet for the upper, all of it being hand-work except a small amount of the latter, which was handled by a derrick. Stone was taken from a small quarry opened about 200 feet west of the north end of the weir and hauled in wagons.

Stones for riprapping the slopes of the gate-house inlet channel were obtained principally from the excavation of the channel itself, this work being finished early in the season.

The small amount of top-soil needed was obtained by stripping meadow-land within the basin about ½ mile from the weir, and was hauled in wagons.

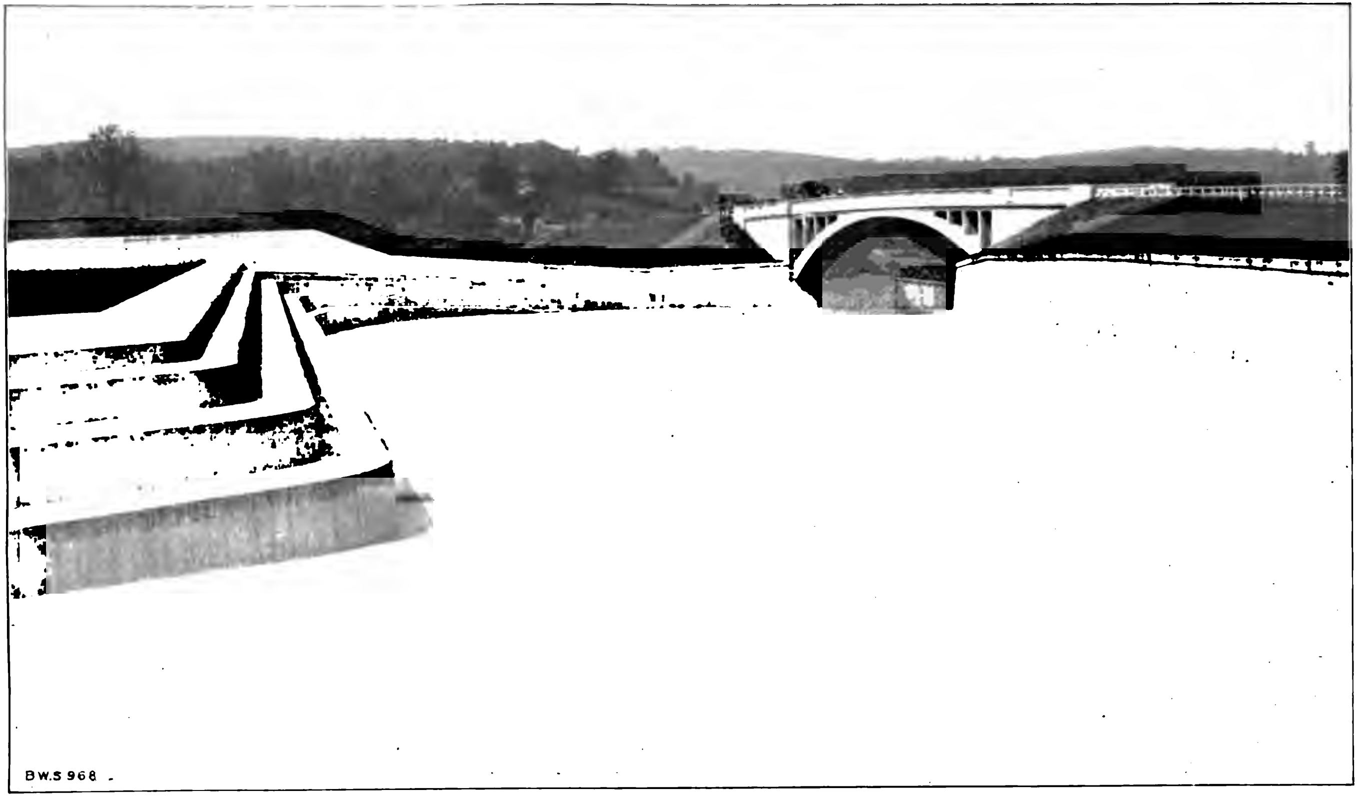
The embankment for the Dividing Weir dike was at first supplied by excavation operations at the Dividing weir. This material was handled by wagons, spread and rolled. When the bank reached the hight of the Upper Gate-chamber floor a temporary fill was made over the chamber. Trains from Temple hill were used in finishing the dike to grade. This temporary fill was afterwards used to fill back of the retaining-walls at the Upper gate-chamber.

The sewer and roadway drainage systems along the dike were completed.

Discharge Channel.—This channel was practically completed during the year. The earth excavation for the bottom was of a gravelly nature, filled with large boulders; the rock was bluestone and shale. Two Cyclone well drills sank holes about 20 feet apart, in which were loaded from 200 to 300 pounds of 40-per-cent. dynamite and exploded. Earth and rock were then loaded by two 70-ton Bucyrus shovels into standard-gage dump-cars, wasting the material, at first, near the easterly end of the channel and afterwards on the temporary dam at the Beaver kill.

Foundations for the north and south side walls were built on solid rock at least 18 inches below the grade of the channel except in a few cases where no excavation was necessary in the channel and the surface rock was hard and durable.

PLATE 3



ASHOKAN RESERVOIR—Waste weir and Spillway (Contract 3) and Spillway bridge. The bridge, built under Contract 111, has a clear span of 175 feet and a rise of 25 feet

BEAVER KILL DIKES AND *CONNECTED STRUCTURES—MONTHLY PROGRESS, 1914

Month (Ends on 20th)	Earth Excavation Cubic Yards	Rock Excavation Cubic Yards	Embankment Cubic Yards	Paving Cubic Yards	Surface Dressing Cubic Yards	Concrete and Cyclopean Masonry Cubic Yards	Cement Barrels
January	10,200	4,600	500	......	......	1,570	2,119
February	1,880	1,600	3,500	......	......	......	......
March	4,300	1,300	......	......	......	......	......
April	16,000	3,300	1,000	......	......	1,761	1,321
May	17,400	7,000	25,200	80	......	3,720	4,163
June	31,700	7,500	127,000	170	......	2,445	3,129
July	7,400	14,870	77,300	200	......	885	1,457
August	11,800	8,700	78,500	470	......	955	1,774
September	20,800	9,700	116,550	......	......	2,210	3,170
October	9,470	4,900	93,900	2,000	......	2,190	3,227
November	650	1,150	63,500	10,180	3,300	1,435	2,189
December	8,650	2,600	18,000	7,150	......	1,012	1,589
For 1914	**140,250**	**67,220**	**604,950**	**20,250**	**3,300**	**18,183**	**24,138**
For 1913	**475,484**	**91,117**	**768,092**	**282**	**2,500**	**50,646**	**55,231**
For 1912	**372,531**	**20,290**	**487,700**	**4,216**	**14,700**	**54,826**	**66,515**
For 1911	**205,648**	**116,280**	**667,797**	**4,450**	**4,500**	**56,431**	**65,653**
For 1910	**76,898**	**115,462**	**791,018**	**14**	**2,400**	**61,847**	**72,066**
For 1909	**221,714**	**28,421**	**678,179**	**80**	......	**72,206**	**85,341**
For 1908	**243,355**	**5,091**	**144,454**	**141**	......	**14,882**	**20,664**
Total to December 20, 1914	**1,735,880**	**443,881**	**4,142,190**	**29,433**	**27,400**	**329,021**	**389,608**

* Connected structures are Waste weir and Spillway channel, Upper gate-chamber, East and West Inlet channels, Dividing weir and Discharge channel

Concrete for the retaining-walls was furnished by a mixer at the southwest corner of the channel. At the westerly half of the north side wall derricks lifted the concrete from narrow-gage cars, while at the easterly end a standard-gage locomotive crane was used. At the easterly portion of the south side wall standard-gage flat-cars transported the concrete to the forms, where it was lifted into place by the locomotive crane. At the westerly portion of this wall narrow-gage equipment and a traveling derrick were used. All expansion joints in both walls were spaced 15 feet apart with weepers every 15 to 25 feet.

Excavated material from the channel was used for back-fill behind the south side wall, a protection of rock fill being used on the slopes of the fills.

Paving and top-soil were placed above the north side wall.

HEADWORKS OF CATSKILL AQUEDUCT

Contract 10—Jules Breuchaud, Contractor

This contract includes the Lower gate-chamber, Special aqueducts, Screen chamber, Waste channel, Aerator, and about 3,400 feet of standard cut-and-cover aqueduct, including the Ashokan Venturi meter.

The yearly progress on this contract, as measured by the partial estimates for payment, was 18.41 per cent., making a total of 89 per cent. completed at the end of the year.

The average force on this contract was 114 men and 44 animals, with a maximum of 265 men and 101 animals.

The arrangement made with the contractor for Contract 3 for living accommodations for the working force in the Main camp was continued.

The plant was continued the same as last year, except that on November 12 the mixer plant near the Lower gate-chamber was dismantled and a ½-yard and a 1-yard Municipal cube portable mixer were installed.

Lower Gate-Chamber.—Work on this chamber, which consisted principally of casting floor blocks and the construction of coal pockets and stairways, was completed during the year.

Aerator.—Work was carried on in the Aerator for the entire year and nearly completed. Most of the excavated material was wasted between the Lower gate-chamber, Screen chamber and West dike, and also along both sides of the Standard aqueduct

south of the Screen chamber. Rock excavation was started as soon as sufficient overlying earth had been removed, 2 channelers and 13 drills being employed. For a portion of the time two shifts per day were worked on rock. Excavated rock was wasted or sent to the main crusher plant.

The basin was excavated to a general level, except that in a few places original rock was below this grade. All depressions are to be filled with concrete so as to get proper drainage. Trenches for the nozzle pipes were channeled in the rock.

The first concrete was placed May 27 in the westerly end of the outlet channel. The concreting of nozzle pipes, supply pipes, side walls and apron blocks was carried on simultaneously. A 1:2:4 mixture was used on all reinforced concrete; a 1:2½:5 for the outlet channel; a 1:3:6 for side walls; and a 1:3:6 with a 2-inch wearing surface of 1:2 mortar for the apron blocks. In setting the forms for apron blocks great care was taken to make the lines straight and all intersections true. After casting they were given a granolithic finish and kept wet for two weeks by being covered with wet sand. Side walls were rubbed with carborundum bricks, generally after a lapse of 72 hours.

The 8-foot steel pipes formerly used for the Esopus Creek stream control at the Olive Bridge dam were furnished by The City to form two parallel lines of supply pipes from the Lower gate-chamber to the Aerator. When in place bulkheads were erected at the Aerator end and the other end was closed by the valves in the manifold of the Lower gate-chamber for purposes of a hydrostatic test.

Grading of grassed areas and roadways adjacent to the Aerator, Mall and Screen chamber was in progress during the greater part of the season.

Waste Channel.—Due to the heavy flow of water at times through the channel the side walls were partially undermined on that portion which had no bottom lining. It was decided, therefore, to line the bottom with concrete to the end of the side walls. A skew-back was cut in the side-wall concrete and invert placed. Concrete was shoveled from a platform at the top of the bank above the channel into a chute leading to a hopper in the channel. From this hopper it was loaded into wheelbarrows and dumped into place.

Standard Aqueduct.—The grading near the Venturi meter was

completed, the slopes grassed and the access road to the gaging manhole surfaced with gravel. The recording apparatus at the Venturi meter was installed.

THREE CONCRETE BRIDGES AND APPROACHES

Contract 111—Ward and Tully, Inc., Contractor

This contract was for the construction of three concrete bridges and approaches intended as a part of the substituted highway system of the East basin near the Main dams.

At the beginning of the year 78 per cent. of the contract, as measured by the partial estimates, was completed. The contract was completed July 1, the final estimate amounting to $145,-138.73.

The average force employed on this contract during the working season was 29 men and 6 animals, with a maximum of 50 men and 14 animals.

No camp was erected for this contract. The forces were housed in buildings already standing, some of which were leased from The City.

The principal items of plant were the same as last year.

The Beaver Kill and Stone Church bridges were completed last year except general cleaning up and placing of wooden guard-rails on the approach fills of the Stone Church bridge, which work was done early in the season.

At the Spillway bridge the remaining reinforced-concrete retaining-walls and floor slabs of the approaches and the setting of the balustrade blocks were completed.

ASHOKAN BRIDGE

Contract 76—Transit Construction Company, Contractor

This contract, for the construction of the Ashokan bridge, a reinforced-concrete structure of 15 spans along and supported on the Dividing weir, and of electric conduits both on and in the vicinity of the bridge, was awarded June 30 and work was begun July 11.

At the end of the year 21 per cent. of the contract, as measured by the partial estimates, was completed.

The average force employed on this contract during the working season was 41 men and 7 animals, with a maximum of 74 men and 14 animals.

PLATE 4

ASHOKAN RESERVOIR---Dividing weir and piers for Ashokan bridge, looking south from north shore. Discharge channel to East basin at left. West basin and Winchell hill at right. Forms and concrete for five arches of bridge are in place. Contract 76

The camp consisted of six buildings built by the contractor on the easterly side of Green hill, a short distance from the bridge. Water was obtained from a protected spring and all refuse was burned in an incinerator.

The plant is located at the north end of the Dividing weir. A cableway with trussed A-frame towers spans from the north end of the northerly abutment to the Dividing Weir gate-house, upon which the tail tower is placed. A 125-horse-power horizontal boiler furnishes steam to run the cableway, engine, mixer and crusher, an additional boiler of 40 horse-power being set up ready for use in case of breakdown. The rock crusher is a No. 2½ Climax, jaw type. Two Ransome mixers, one of one yard and the other of ¾ yard capacity, were used for mixing the concrete, the latter machine being used principally in emergencies. A steel bucket conveyor elevates the crushed stone to a screen and storage bin, the latter holding 10 cubic yards of screenings, 35 cubic yards of crushed stone and 10 cubic yards of tailings, from which chutes lead to the mixer. A stone and sand measuring hopper of large center area with small end areas, and a tipping water barrel were located directly over the mixer. The crusher was run by a "Vim" 10-inch by 12-inch cylinder engine. Water was pumped from the East Inlet channel into two elevated water-tanks, holding 4,900 gallons, near the boiler and mixer. A vertical boiler furnished steam for protecting concrete placed during freezing weather. A small air-compressor was used for blowing out the pipe-lines. There were also two cement houses, a steel shed, stone house, oil house and an office located near the head tower of the cableway.

Storage piles of crushed stone, screenings and sand are located near the mixer, to which they can be taken by wheelbarrows up an inclined runway.

Timber bents were framed and erected, upon which were placed, by cableway, steel centers. Each rib was in two sections, pin-connected at the crown, a 2-inch tie-rod connecting the ends at the haunch. Six ribs were furnished to each of five spans, so that the falsework and the concreting of arch rings for the bridge could be done in three units of five spans each. Oak wedges under the ribs gave the necessary means for adjustment and ultimate lowering of the centers. As soon as the centers were completed lagging and necessary forms were set in place. Three operations were necessary to finish an arch: first the piers were concreted to

within 13 inches of the springing-line; then the "umbrella" section, extending from the piers about eight feet along the arch, was cast, after which the center portion of arch ring was completed. The reinforcement consisted of ovoid steel bars held in place by structural-steel cross frames.

Concreting began October 12. Sand was obtained from the Winchell sand-pit. Field stone collected from old stone walls was used for the coarse aggregate. In the piers the concrete was a mixture of 1:2¾:5½, using 2-inch stone; that for arch concrete was 1:2:4, using ¾-inch stone. The concrete was dumped into 2-yard bottom-dump Steubner buckets and pushed by hand along a narrow-gage track to the required position under the cableway which carried it to the forms. The average output was 12 to 14 cubic yards per hour.

Telltales were used to register the amount of deflection due to loading the arches. When concreting the "umbrella" section a deflection of 1/16 inch to ⅛ inch was observed at the springing-line and no movement at the crown. Finishing the arch gave a deflection at the crown of ⅝ inch and no further movement at the haunches. Considerable deflection was noted due to differences in temperature, the greater changes, however, coming on the unloaded arches. At the end of the year the arch rings for the five southerly spans were completed.

CONTROLLING VALVES AND APPURTENANCES

Contract 31—*Ogden Iron and Steel Manufacturing Company, Contractor*

This contract is for furnishing and installing four 48-inch controlling valves with the necessary operating mechanisms in the Lower gate-chamber. The steel keys in the bronze guide shoes had rusted badly, making it difficult for the plug to slide and causing an overloading of motor. These steel keys were replaced through market order with bronze to eliminate this difficulty. The test for final acceptance was made and the contract completed December 23, the final estimate amounting to $54,900.

SLUICE-GATES, STOP DISKS AND OPERATING MECHANISMS

Contract 41—*Ogden Iron and Steel Manufacturing Company, Contractor*

Four 5-foot by 15-foot sluice-gates with operating mechanisms for the Dividing Weir gate-house and the four 66-inch stop disks

with the necessary frames for the Upper gate-chamber are included in this contract. The operating mechanisms for the four sluice-gates were placed and various tests and adjustments were made this year. The test for final acceptance was made and the contract completed December 15, the final estimate for this department amounting to $21,990.

SLUICE-GATES, GATE-VALVES AND OPERATING MECHANISMS

Contract 42—Coffin Valve Company, Contractor

The material furnished at the Ashokan reservoir under this contract includes eight 3-foot by 8-foot twin sluice-gates, eight 20-inch gate-valves and eight 60-inch gate-valves for the Upper gate-chamber, and ten 60-inch gate-valves for the Lower gate-chamber, with their operating mechanisms. The installation of the operating mechanisms was completed and final tests made toward the end of the year.

SLUICE-GATES, GATE-VALVES AND OPERATING MECHANISMS

Contract 43—Coffin Valve Company, Contractor

Included in this contract are four 48-inch gate-valves and two 36-inch gate-valves for the Lower gate-chamber, nine 6-inch gate-valves for the Lower gate-chamber and Aerator, and nine 6-inch check valves for the Upper gate-chamber. Various preliminary tests and adjustments were made, as was also the final acceptance test.

SLUICE-GATES AND OPERATING MECHANISMS

Contract 44—Coldwell-Wilcox Company, Contractor

This contract includes one 6-foot by 15-foot sluice-gate for the Screen chamber and two 18-inch by 24-inch sluice-gates for the Headworks. Brick struts were added by the Board's forces to the gate frame of the 6-foot by 15-foot gate at the Screen chamber. This contract is complete except the installation of one 18-inch by 24-inch sluice-gate in the Aerator.

HYDRO-ELECTRIC POWER EQUIPMENT

Contract 56—L. K. Comstock & Company, Contractor

This contract, for the installation of a hydro-electric equipment, consists of two turbines and two generators, of approximately 250 kilowatts capacity, in the Lower Gate and Screen

chambers, with an electric cable between these chambers. The installation of all mechanisms was completed and the equipment was put in service in June. The turbine test under Item 3 remains to be done.

RACKS, STOP SHUTTERS AND SCREENS

Contract 91—*Vulcan Rail and Construction Company, Contractor*

The only work during the year on this contract, for the installation of timber and steel racks in the Upper gate-chamber and stop shutters in the Screen chamber, and the delivery of stop shutters for the Upper gate-chamber and screens for the Screen chamber, consisted in the replacing of defective bolts in the racks. The contract was completed June 25, the final estimate amounting to $32,123.29.

GAGING AND METERING APPARATUS

Contract 110—*Builders Iron Foundry, Contractor*

This contract, for furnishing, delivering and installing gaging, metering and other apparatus for various structures along the line of the Catskill aqueduct, was awarded January 6, and the first material for use in this department was delivered March 21. The articles for this department, consisting of reservoir scales, gages, gage-well covers, a 3-inch water-meter, 1-inch valves, 6-inch strainers and a warning device, were delivered and necessary installations made.

LADDERS, GRATINGS, RAILINGS AND PLATES

Contract 112—*Vulcan Rail and Construction Company, Contractor*

This contract includes furnishing, delivering and installing bronze ladders in the Olive Bridge dam and bronze ladders, steel gratings, wrought-iron pipe railings and steel plates in the Upper gate-chamber. The steel plates over shaft trenches and hand railings were completed in July.

STOP SHUTTERS AT GATE-CHAMBERS

Agreement 87—*Vulcan Rail and Construction Company, Contractor*

Under this agreement for furnishing and delivering stop shutters and other apparatus at gate-chambers along the Catskill aqueduct, only the delivery of one steel rack rake, for removing debris

from the faces of the Upper gate-chamber, is included in this department and this was delivered March 20.

Real Estate Division

FENCES AT RESERVOIRS AND ALONG CATSKILL AQUEDUCT

Contract 101 (*District* 1)—*The Degnon Contracting Company, Contractor*

This district includes furnishing and erecting about 40.9 miles of wire fencing on concrete posts around the Ashokan reservoir. This fencing, in conjunction with guard-rails to be constructed under another contract on the dikes and dams, will make a completely enclosed fence line between the circumscribing public highways and the shore of the reservoir.

At the beginning of the year 62 per cent. of the contract, as measured by the partial estimates for payment, was completed. The work was completed December 3 and the final estimate amounted to $67,662.23.

No general camp was established for this contract, as most of the employees were residents of this vicinity.

Manufacture and erection of posts and the erecting of fence were carried on as last year.

A portion of the fencing erected in the summer of 1913 afforded a chance for study of frost upheaval, snow loading and temperature contraction, which affected equally the Knox fence woven in the field and the American Railroad fence woven at the factory.

Frost upheaval affected the fence posts set in earth to a greater or less extent, in proportion to the amount of clay in the soil. Along the northerly and westerly portions of the reservoir the soil is mostly of clayey nature and the lifting of posts by frost was general.

Where successive snow-banks form over the fence with consequent successions of freezing and thawing, great strain is brought to bear upon the wires and posts. There were several places where this strain was sufficient to permanently stretch the wires and two places where the wire was broken.

Temperature contractions do not appear to have any permanent effect on the line-wires, but may be the cause of an occasional broken post.

Concrete around posts and braces was kept well below the surface of the ground and the tops were sloped to reduce the grip

of the frost as much as possible. Gate-post braces were lengthened to take a flatter slope and reduce the lifting effect of wire-pull and the allowable distance between straining posts was decreased to localize any accidental damage to the fence.

SURFACING HIGHWAYS AROUND THE ASHOKAN RESERVOIR

Contract 151—State Highway Construction Co., Contractor

This contract is for surfacing with bituminous pavement about

ASHOKAN RESERVOIR—Completed portion of Road 2 looking west near Sand hill. Contract 151. Note field-woven type of boundary fence constructed under Contract 101

30 miles, and with water-bound macadam pavement about three miles, of substituted new highways around the Ashokan reservoir, which, with the highways on top of dikes and dams to be surfaced under a subsequent contract, will make a complete circuit of highways for public use around the reservoir.

The work at the beginning of the year was 9 per cent. completed and at the end of the year was 84 per cent. completed, as measured by the partial estimates for payment.

PLATE 5

ASHOKAN RESERVOIR—Placing seal coat on bituminous wearing surface. Road 11. Contract 151. Note field-woven type of boundary fence built under Contract 101

PLATE 6

ASHOKAN RESERVOIR Drainage course, 6-inch bottom course and finished macadam road before bituminous treatment. Contract 151

The average force employed on this contract was 324 men and 105 animals, with a maximum of 778 men and 244 animals. The working season on asphalt was from May 5 to October 26. The working season on stone foundation was from April 14 to October 29.

Nine small camps located on City property along the 33 miles of highways housed some of the workmen. Many of the employees were natives having homes in the vicinity.

The plants for stone crushing were portable road-building outfits, consisting of engine, crusher, bins, etc., which were moved from place to place as the work progressed.

The four asphalt plants consisted of dryers for stone, kettles for heating asphalt, and mixers, with boilers and engines for power. Two of the plants contained the engine, mixer and dryers in a single unit and could be moved and set up ready for running in two or three days. The other two plants had the various parts separate and required more or less foundation work for setting. The time required to move these was from one to two weeks.

The stone around the eastern and southern portions of the reservoir is blue sandstone; that around the northern and western portions, blue, gray and red sandstones, predominating in the order given. Samples of each were tested by abrasion but did not show any marked difference in wearing qualities.

As crushing proceeded, it was found that the foreign boulders gave by far the least satisfactory product; also that the thickness of the flat stone had very little, if any, influence on the shape of the output so long as the thickness of the stone was not less than ¾ inch. Only such stone was used as gave the best crusher product.

The screens were adjusted to produce a relatively large percentage of fine stone. A screen with 21 inches of ½-inch holes, 36 inches of 1½-inch holes, and the balance of 3-inch holes, gave the best-graded product.

The crushing of the 3-inch stone for the foundation course, with the above adjustment of screens, gave nearly the relative amounts of the various sizes of stone required. There was generally a shortage of dust for filling and this was provided from other sources or the crusher had to run a portion of the time with close-set jaws.

Prior to the partial flooding of the West basin of the reservoir during the winter of 1913-1914, three miles of the substituted highways had to be put in condition for travel. The highways

had been graded under another contract. The surfacing was to be done under this contract, but on account of the lateness in 1913 of the awarding of this contract it was impossible to complete the surfacing of this section before flooding, and the road was opened for the winter after the first 3-inch layer of the foundation course was placed. In the spring there were some ruts and a few places where it had broken up, but the layer had been practically undamaged, and after the second 3-inch layer had been placed the foundation course was in every respect as good as though built in the usual manner of having the top 3-inch course follow closely after the bottom 3-inch course.

The work was divided into four groups, each group having a number of stone-crushing outfits and one or two asphalt plants. These outfits had to be moved several times as the work progressed. Group "A" included the roads along the southerly side of the West basin from the vicinity of the Main dams to Boiceville; Group "B" those along the northerly side of the West basin from Boiceville to Ashokan; Group "C" those along the northerly side of the East basin from Ashokan to West Hurley, and Group "D" those along the southerly side of the East basin from West Hurley to the vicinity of the Main dams.

On the roads in Group "A" the plant consisted of one to four stone outfits and one asphalt outfit. On these roads 51,700 linear feet of 6-inch foundation courses 14 feet wide and 88,000 square yards of 2-inch bituminous surface and seal coat were laid. Effective progress was made on 155 days out of a total of 170 days for foundation courses, and 98 days for bituminous surfacing out of a total of 160 days, so that the total daily average rate for foundation courses was 304 linear feet and for bituminous surface 550 square yards, and the daily average rate per outfit was 142 linear feet on the foundation courses and 550 square yards on the bituminous surfacing.

The plant on the Group "B" roads consisted of one or two stone outfits and one asphalt outfit. On these roads 18,200 linear feet of 6-inch foundation courses 16 feet wide and 31,200 square yards of 2-inch bituminous surface and seal coat were laid. Effective progress was made on 75 days out of a total of 89 days for foundation courses, and 44 days for bituminous surfacing out of a total of 71 days, so that the total daily average rate for foundation courses was 193 linear feet and for bituminous surface 440 square yards, and the daily average rate per outfit was 124 linear feet

ASHOKAN RESERVOIR—Placing bituminous wearing course on cleaned surface of bottom stone courses. Highways built under Contract 151

ASHOKAN RESERVOIR—Stone heater, asphalt measuring hopper and mixer for bituminous road surfacing. Contract 151

for the former and 440 square yards for the latter.

On the roads in Group "C" the plant consisted of one to four stone outfits and one to three asphalt outfits. On these roads 43,000 linear feet of 6-inch foundation courses 16 feet wide were laid and 77,200 square yards of 2-inch bituminous surface and seal coat. Effective progress was made on 127 days out of a total of 146 days for foundation courses, and 54 days for bituminous surfacing out of a total of 79 days, so that the total daily average rate for foundation courses was 295 linear feet and 977 square yards for bituminous surface, and the daily average rate per outfit was 121 linear feet on the foundation courses and 654 square yards on the bituminous surfacing.

On roads, Group "D", the plant consisted of one or two stone outfits, one of which consisted of three crushers and one or two asphalt outfits. On these roads 40,500 linear feet of 6-inch foundation courses 14 feet wide were laid and 29,500 square yards of 2-inch bituminous surface and seal coat. Effective progress was made on 124 days out of a total of 154 days for foundation courses, and 28 days for bituminous surfacing out of a total of 37 days, so that the total daily average rate for foundation courses was 263 linear feet, and 797 square yards for bituminous surface, and the daily average rate per outfit was 144 linear feet on the foundation courses and 738 square yards on the bituminous surfacing.

The road built for a foundation of the bituminous pavement was water-bound macadam and differed from the ordinary roads of that type principally in having two courses built of large-sized stones, so that the surface, when swept, should be rough and afford a good hold for the bituminous concrete.

Foundation course that had been subject to traffic gave after sweeping a much firmer and better base for the bituminous surfacing than that which had received no traffic, and for this reason it was a decided advantage to finish the bottom course well in advance of the surfacing.

The bituminous concrete was mixed so that the resulting mixture contained, by weight, 6¼ per cent. of asphaltic cement, the stone ranging in size from ½ inch to 1½ inches. The maximum temperature of the stone, after drying and heating, was 225 degrees Fahrenheit, and the asphalt ranged from 275 degrees Fahrenheit to 300 degrees Fahrenheit, as it was found that these temperatures reduced the draining from the wagons to a minimum.

This resulting mixture was hauled to the place of laying in

SURFACING HIGHWAYS—CONTRACT 151—MONTHLY PROGRESS, 1914

Month (Ends on 1st)	Excavating and Grading: Preparation of Road Bed Linear Feet	Excavating and Grading: Miscellaneous Earth and Rock Cubic Yards	Drainage Course: Broken Stone Cubic Yards	Drainage Course: Vitrified Pipe Linear Feet	Bottom Course Broken Stone Cubic Yards	Bituminous Surface: Surface Square Yards	Bituminous Surface: Bitumen in Asphalt Cement Tons	Bituminous Surface: Asphalt Cement Barrels
February	......	......	......	......	......	......	......	......
March	......	400	......	......	......	......	......	......
April	......	......	......	......	......	......	......	......
May	8,300	5,290	1,680	4,460	1,660	......	......	......
June	22,600	3,225	3,900	500	6,510	13,400	114	700
July	23,100	4,520	5,470	4,490	8,100	29,200	273	1,675
August	19,500	4,150	2,530	730	8,300	25,600	323	1,982
September	30,800	9,300	1,050	350	7,300	30,900	317	1,945
October	21,900	5,050	650	1,300	9,300	67,600	563	3,454
November	15,100	4,880	280	40	1,500	63,200	587	3,600
December	5,600	3,710	1,050	170	40	......	......	......
January	......	785	30	......	......	......	......	......
For 1914	**146,900**	**41,310**	**16,640**	**12,040**	**42,710**	**229,900**	**2,177**	**13,356**
For 1913	**22,000**	**9,905**	**5,920**	**5,500**	**5,630**	**6,900**	**77**	**468**
Total to December 31, 1914	**168,900**	**51,215**	**22,560**	**17,540**	**48,340**	**236,800**	**2,254**	**13,824**
Total contract quantity	**180,000**	**46,000**	**26,000**	**8,000**	**55,000**	**270,000**	**3,500**	......

ASHOKAN RESERVOIR—Typical concrete sign-post and guard-rail built under Contract 151 for highways

ASHOKAN RESERVOIR—Looking west along Road 2. Contract 151

bottom-dump wagons. The mixture, temperature not less than 150 degrees Fahrenheit, was dumped onto platforms consisting of planks placed loosely side by side a few feet in advance of laying, from where it was shoveled into place and spread with rakes to the requisite 2-inch thickness for rolling with an 8-ton tandem roller. The compression due to rolling was generally 5/8 to 3/4 inch.

The amount of asphaltic cement, including seal coat, used per square yard of road averaged 2.3 gallons. A single plant (Cummer) laid as much as 1,500 square yards of 2-inch bituminous surfacing in one day, but 700 to 800 square yards, omitting delays, were about the average.

After rolling, a seal coat, not to exceed one gallon per square yard, was spread and covered with stone chips. The dry stone chips were spread in two operations. The first spreading was very light and the rolling resulted in forcing the chips into the seal coat between the interstices of the coated stones of the wearing surface. After a thorough rolling a more liberal coating of stone chips was spread and rolled. The surface was then ready for traffic.

A crown of 1/4 inch per foot was at first adopted, but was later increased to 3/8 inch per foot. This provided against any flattening of the crown due to traffic and afforded better drainage.

UP-KEEP OF STRUCTURES

Forestry

The Board's forces continued regular planting work in addition to the tree planting done under Contract 156.

A considerable area of forest land was cleared out and large numbers of dead trees (principally chestnut affected with the chestnut blight) and quantities of undergrowth were cut and burned. This work was for the purpose of facilitating the fighting of forest fires.

As the trees in the Shokan and Olive Bridge nurseries were getting very large it was decided to move them in the spring and accordingly about 20,000 were transplanted at Shokan near Sand hill and at the Winchell Hill tower and a quantity forwarded for planting along the aqueduct line from Olive bridge to Bonticou tunnel. All the trees in the Shokan nursery were set out and this nursery was discontinued as the soil is not suitable for nursery work. At the Olive Bridge nursery about 80 seed-beds were re-seeded but no efforts were made to transplant. The results from

the seeds were not satisfactory on account of the extremely dry, hot season and poor quality of seed. During the year seed was collected from white pine, arbor vitae and hemlock. About 65 bushels of various cones were collected from which were secured 50 pounds of clean seed, enough to re-seed all seed-beds in the nursery. Several bushels of oak seed (acorns) of several varieties were planted at the nursery, this being the first effort to raise deciduous trees.

The growth of the 350,000 transplants has been satisfactory. All of these trees are available for transplanting in the spring of 1915. Some new varieties have been tried in the seed-beds this year, such as European larch and Douglas spruce, but, except for ornamental purposes, the white pine, red pine and arbor vitae seem the most satisfactory for the purposes in hand.

Sanitation

The individual sanitary treatment of the isolated dwellings on the Esopus watershed was continued by forces of the Board. Places were treated as described last year so that by the end of the year new outhouses were provided at 36 places, and the old ones renovated at 181 places, making a total of 65 places provided with new outhouses, and 289 places had the old outhouses renovated.

Ulster and Delaware Railroad Removal

The Ulster and Delaware Railroad Company continued minor work on its new line, which continued in operation all year. The company completed the removal of its remaining property from along the abandoned line.

Storage of Water in Ashokan Reservoir

Storage of water in Ashokan reservoir was continued. Water was wasted through the regular waste channels until January 8, at which time the water elevation in the West basin was 501.6. After this no water was wasted until January 31, when the water reached Elevation 521.9. The flow of Esopus creek was about 1,920 cubic feet per second, while wasting was at the rate of 825 cubic feet per second, the water reaching its highest point at Elevation 526.9 on February 2, at which time available water stored in the West basin of the reservoir amounted to 6,000 million gallons.

On March 28 a storm caused the flow in Esopus creek to reach a maximum of 7,548 cubic feet per second and the water

elevation in the West basin reached 539.9 on March 30, available water amounting to 10,500 million gallons. From this time until May 13 a series of storms, during one of which, on May 5, there was a maximum rainfall of 1.26 inches, caused a flow in the creek of from 780 to 6,900 cubic feet per second. During this time the water wasted through the waste channel reached a maximum of 3,200 cubic feet per second and water in the West basin fluctuated, the minimum elevation being 521.7 on April 29, and 525.4 on May 13 when 5,560 million gallons were available. From this time until the end of the year there were no storms that particularly affected the flow of the Esopus creek, which reached a minimum to date of 8 cubic feet per second on October 14 at Cold brook. Low flows extended over a considerable period, the water in the reservoir varying from Elevation 519.9 on May 31 to Elevation 540.8 on December 31 in the West basin, and from Elevation 500 (empty) to Elevation 515 in the East Basin on December 31, making 13,500 million gallons available. The wasting of water varied from 8 to 1,056 cubic feet per second until June 26, after which only small amounts of water were wasted, except early in November, when the water that had been impounded in the East basin was drawn off and wasted to remedy conditions found during color observations and to permit repairs to the gates in the Upper gate-chamber. In December this basin was again flooded to Elevation 515 with water from the West basin. At various times water was supplied to the Catskill aqueduct for testing purposes. The amount of water thus supplied varied from three cubic feet per second, or two million gallons per day to 774 cubic feet per second or 503 million gallons per day.

Experimental Operation of Headworks

A small force was organized in March to test the operation of the gates and valves and keep the installations in the Headworks in condition for service. Power for the gate and valve trials was furnished by the hydro-electric plant at the Lower gate-chamber and by a 16-horse-power gasoline engine. Water was admitted to the turbines at the Lower gate-chamber for the first time on June 11 and the generators and motor-driven valves given trial runs.

The stop-disk frames in all wells and the sluice-gate frames in six of the eight wells in the Upper gate-chamber were concreted in place. Some of the bronze studs in the stop-disk frames and the lock-nut studs in the gate-leaf wedges were replaced with steel

studs. At the Esopus and Tongore Siphon chambers and Ashokan Screen chamber the gate frames were held by brick laid in mortar.

Screen racks were built to protect the waterway openings on the east face of the Upper gate-chamber and a small log boom was placed at the easterly end of the East Inlet channel.

Temporary shelters were constructed to protect the operating stands and switchboards which were exposed to the weather.

Owing to the excessive growths from weeds and stumps in the areas previously cleared it was found necessary to re-clear the entire West basin, which was done by an increased force of Board laborers. All materials were dried, piled and burned and a greater part of the grass-land was burned over as well.

Thermophones

For the purpose of observing temperature within a mass of masonry thermophones were embedded at various locations in the arch of the Spillway bridge built under Contract 111.

Readings were taken at 15-minute intervals while the concrete was being placed. After the completion of the concrete observations were made at 3-hour intervals for four days, continuing to date with daily readings. The temperature of the atmosphere at the time of reading, and the daily maximum and minimum, were recorded.

Thermophone 10, which is surrounded by the greatest mass of masonry, showed a rapid rise to a maximum of 115 degrees Fahrenheit when the concrete was nearly four days old. Thereafter the temperature gradually fell until at about a month's age the temperature of the masonry was the same as the outside air. The minimum recorded with this thermophone during the winter months was 13 degrees Fahrenheit. The other thermophones showed smaller maxima and a more rapid adoption of the atmospheric temperatures.

Thermophone 8, which occupies a position most exposed to outside temperature, indicated a maximum of only 74 degrees Fahrenheit, and had the same temperature as the outside air in about six days. This coil recorded a minimum of —2 degrees Fahrenheit.

A table following gives the limiting features in the action of the various thermophones from the time of placing the concrete in September, 1913, through the winter of 1913-1914:

Thermophone	Temperature of Outside Air at Time of Placing Masonry Degrees		Maximum Temperature Degrees	Age at Maximum Temperature in Days	Age when Masonry Reached Same Temperature as Outside Air in Days	Minimum Temperature During Winter Months Degrees
	Maximum	Minimum				
1	82	46	73	2 1/5	6	10
2	82	46	88	2⅛	9	9
3	82	46	88	2	9	7
4	61	45	87	2½	10	3
5	61	45	95	3	10	7
6	61	45	84	4	10	6
7	61	45	93	2¼	10	7
8	61	45	74	2¼	6	—2
9	70	59	Operated only for 13 hours			
10	70	59	115	3¾	34	13
11	70	59	97	5¼	34	9

At 7 A. M. on September 3 the highest thermophone temperature during the summer was recorded as 88 degrees Fahrenheit at Thermophone 1, the outside temperature at that time being 73 degrees Fahrenheit, while the maximum temperature for the 24 hours preceding was 89 degrees Fahrenheit at about noon.

The highest outside temperature of the summer was recorded on May 27 at 92 degrees Fahrenheit at about noon, but owing to a disarrangement of the recording instrument no thermophone readings were obtained during this hot spell.

These observations will continue throughout the winter of 1914-1915 so as to determine the temperature range of concrete arches in cold weather.

At the Traver Hollow, Esopus and Bushkill bridges, built under Contract 49 in 1913, measurements were made and records kept throughout the year of temperature changes. At the Traver Hollow bridge, the maximum change in length of 3.88 inches was noted on January 16, when the minimum temperature reached 12 degrees Fahrenheit below zero, and again on February 20 with the temperature at seven degrees below zero. The conditions at this bridge were typical of the other bridges, only that the movements were more pronounced because of its greater length.

NORTHERN AQUEDUCT DEPARTMENT

RALPH N. WHEELER, *Department Engineer*

The limits of the Northern Aqueduct department remained the same as at the end of 1913, comprising that portion of the Catskill aqueduct extending from the upper end of the Esopus siphon to the north side of the Hunters Brook valley, covering a length of 60.1 miles.

ORGANIZATION

DIVISIONS AND EMPLOYEES

As a result of the completion of practically all the major contracts the division organizations of the Wallkill and Newburg divisions were disbanded during the year, and the operations of these divisions, with the Esopus, practically confined to up-keep work. Transfers to other departments and resignations reduced the engineering force following the completion of construction work, the increases in the weekly roll resulting from unwatering operations at the Hudson Drainage shaft and up-keep work.

S. F. Thomson, Acting Division Engineer, Wallkill division, separated from the force on June 15, and his place was taken by Transitman John C. Groves, transferred from the City Aqueduct department.

The services of Alexander Thomson, Jr., Division Engineer, Newburg division, and Frank L. Clapp, Acting Division Engineer, Hudson River division, ceased on March 31, 1914, and December 31, 1913, respectively, and the work on these divisions was thereafter put directly under the supervision of the Department Engineer.

EMPLOYEES IN NORTHERN AQUEDUCT DEPARTMENT—1914

	JANUARY 1	DECEMBER 31	MAXIMUM	MINIMUM
Engineers and clerks	53	26	53	24
Laborers	31	68	71	27

The Gwyer House, Bay View avenue, Cornwall-on-Hudson, was occupied by the department offices up to June 1, after which the offices were moved to the second floor of the Savings Bank building, Cornwall-on-Hudson. An additional room was rented in a nearby building to provide additional storage and office facilities.

EXECUTIVE DIVISION

Ralph N. Wheeler, *Department Engineer,* Cornwall-on-Hudson

On October 2 Assistant Engineer Eliot N. Smith, in charge of the division office, resigned, the routine work of this division then coming directly under the Department Engineer. The force varied from a maximum of nine to a minimum of six at the close of the year. Up-keep work on the Hudson River and Newburg divisions was supervised directly by the Department Engineer. The routine work through the year consisted largely of correspondence and the preparation and checking of monthly estimates, time reports, weekly progress reports, final estimates, etc. General supervision was exercised over all hydrostatic tests of aqueduct, computations in connection with same generally being made in this division. Special attention was given to the preparation of final estimates with a view to securing uniformity of interpretation and procedure. Final estimates for Contracts 2, 90, 94, and 101 (Districts 4 and 5) were reviewed. Supervision of construction under Contract 160, for Moodna Siphon supplementary shaft and tunnel, awarded during the year, came under the Department Engineer.

ESOPUS DIVISION

Arthur S. Buss, *Acting Division Engineer,* High Falls

The division office buildings were continued as headquarters. No section organization was maintained. The work consisted largely of conducting hydrostatic tests of the aqueduct and operations in connection with up-keep of the various structures, the review and filing of records, etc. The force varied from a maximum of 15 men in January to a minimum of 10 men in July.

WALLKILL DIVISION

John C. Groves, *Transitman,* New Paltz

The lease of the two floors used as a division office was terminated May 1, and new quarters consisting of two rooms were taken. No section organization was maintained, the engineering force being practically disbanded with the completion of construction. The various section offices were occupied for storage purposes only. The year's work consisted of compiling, indexing and filing records of construction work, and miscellaneous operations in connection with up-keep. The force ranged between a maximum of 16 and a minimum of 8 and consisted largely of laborers.

NEWBURG DIVISION

Ralph N. Wheeler, *Department Engineer,* Cornwall-on-Hudson

The division organization was disbanded March 31, all operations on this division then coming under the supervision of the Department Engineer. All leases for office space were terminated by March 31. Work on the division consisted entirely of up-keep operations. A small field office was established for use in connection with this work. The force varied from a maximum of 11 to a minimum of 3.

HUDSON RIVER DIVISION

Ralph N. Wheeler, *Department Engineer,* Cornwall-on-Hudson

The division as a separate organization was disbanded at the end of last year, and all work was placed under the supervision of the Department Engineer. Section 2 organization was maintained for the construction under Contracts 90 and 160 and unwatering operations at the Hudson Drainage shaft. Work for the year consisted of construction, Contracts 90, 94, 107 and 160, unwatering operations at the Hudson Drainage shaft, hydrostatic tests at Moodna-Hudson pressure tunnel and up-keep operations throughout the division. The force varied from a maximum of 42 to a minimum of 12.

PEEKSKILL DIVISION

George P. Wood, *Division Engineer,* Peekskill

In May the supervision of all construction work was combined into one section, under the charge of Assistant Engineer Seymour B. Bunker. The force ranged between a maximum of 22 and a minimum of 15. Operations for the year covered the construction under Contract 2 and Contract 101 (District 5) and up-keep work.

REAL ESTATE

Surveys and plans were prepared for a permanent easement for a right-of-way from the Gallows Hill road to the South chamber of Sprout Brook siphon. A few concrete boundary monuments were set. The aqueduct center line was re-established throughout the department by concrete monuments at all points of curve and points of tangent, and in addition monuments were placed on long tangents. Unmonumented property corners can be readily determined from the above center line.

PLATE 9

CATSKILL AQUEDUCT—Hudson pressure tunnel. Blow-off conduits at river level with temporary superstructure of East shaft at right and Breakneck chamber up-hill. Contract 90

CONSTRUCTION

Moodna Siphon Supplementary Shaft and Tunnel

Contract 160—*Oscar Daniels Company, Contractor*

This contract for the construction of the Moodna Siphon supplementary shaft and tunnel was awarded November 12, and work was begun November 21. Activities to the end of the year were confined to the assembling and installing of plant around the top of Shaft 7, the erection of head-frame, and a group of camp buildings a short distance north of the foot of the old spoil-bank. On December 31 excavation in the upraise over the supplementary shaft, 7-A, was started. A drill machine was set up at Shaft 8 for drilling a hole through the closure plug, and an electrically-driven hoist was also set up near this shaft. In addition to the above equipment a large number of tunnel cars, drills, rails and miscellaneous equipment was delivered on the work. All machinery, including hoists, compressors, pumps, etc., is electrically operated.

Electric current was furnished by the Central Hudson Gas & Electric Company over The City's 33,000-volt transmission line along the aqueduct right-of-way from the vicinity of St. Andrews to Shaft 7. Work on this line was begun in October and completed so that current was available over same December 27. An outdoor transformer station was provided at Shaft 7, through which current is available at 5,700 or 2,200 volts. Power service is supplemented by a 5,700-volt line running along the public highway from the electric company's Cornwall station to the shaft.

Completion of Hudson Pressure Tunnel

Contract 90—*The T. A. Gillespie Company, Contractor*

At the close of 1913 all work on this contract had been completed with the exception of miscellaneous details in and around the top of the East shaft.

Repairs to concrete lining in the East shaft were made in January, and the float and cage guides were tested by templet from the top to points slightly below Breakneck tunnel. The cast-steel cover was placed on the shaft curb, and the stressing of the anchor-bolts was begun February 16 and completed on February 20. This stressing operation required the use of eight 50-ton hydraulic jacks. The jacks were operated simultaneously, two each on the bolts at ends of normal diameters. Each bolt was elongated by increments of about 0.05 inch to a total of 0.21 inch, which corresponds to an

initial stress of 89 tons per bolt. The complete stressing required 33 set-ups of each pair of jacks and stressing yokes.

The little concrete work remaining at the beginning of the year in the Drainage Chamber substructure was completed. Grading, trimming slopes and refilling around the Drainage chamber were completed in January. The removal of plant and cleaning up were delayed by severe weather and snow, but were finally finished March 23, which date marked the completion of the contract. The final estimate amounted to $1,496,829.43.

Cut-and-Cover Portions and Three Grade Tunnels

Contract 2—Thomas McNally Company, Contractor; Benjamin B. Odell, Jr., Receiver

Work on this contract, while nominally under the same superintendents as at the close of 1913, namely, Spring Hill Construction Co., Cleveland Tunnel Construction Co. and John J. Hart, was finished under the direction of the receiver.

Up to April operations were suspended, with the exception of cleaning Garrison tunnel and Garrison cut-and-cover. The principal construction work for the season, which was begun in April, was in the stretch between Garrison tunnel and Sprout Brook siphon, and comprised the completing of refilling over the aqueduct, the refilling and grading of rights-of-way, the building of a road embankment where the Albany Post road crosses the aqueduct, grading and smoothing spoil-banks and other miscellaneous work in connection with drainage ditches, culverts, boundary walls and post and rail fences. The plant consisted of a Thew automatic steam shovel which loaded refill material from former spoil-banks or borrow-pits, and two locomotives with cars, track, etc. Concrete work was limited to the building of an overhead brook channel, a small bridge near the same point and head-walls for a few pipe culverts.

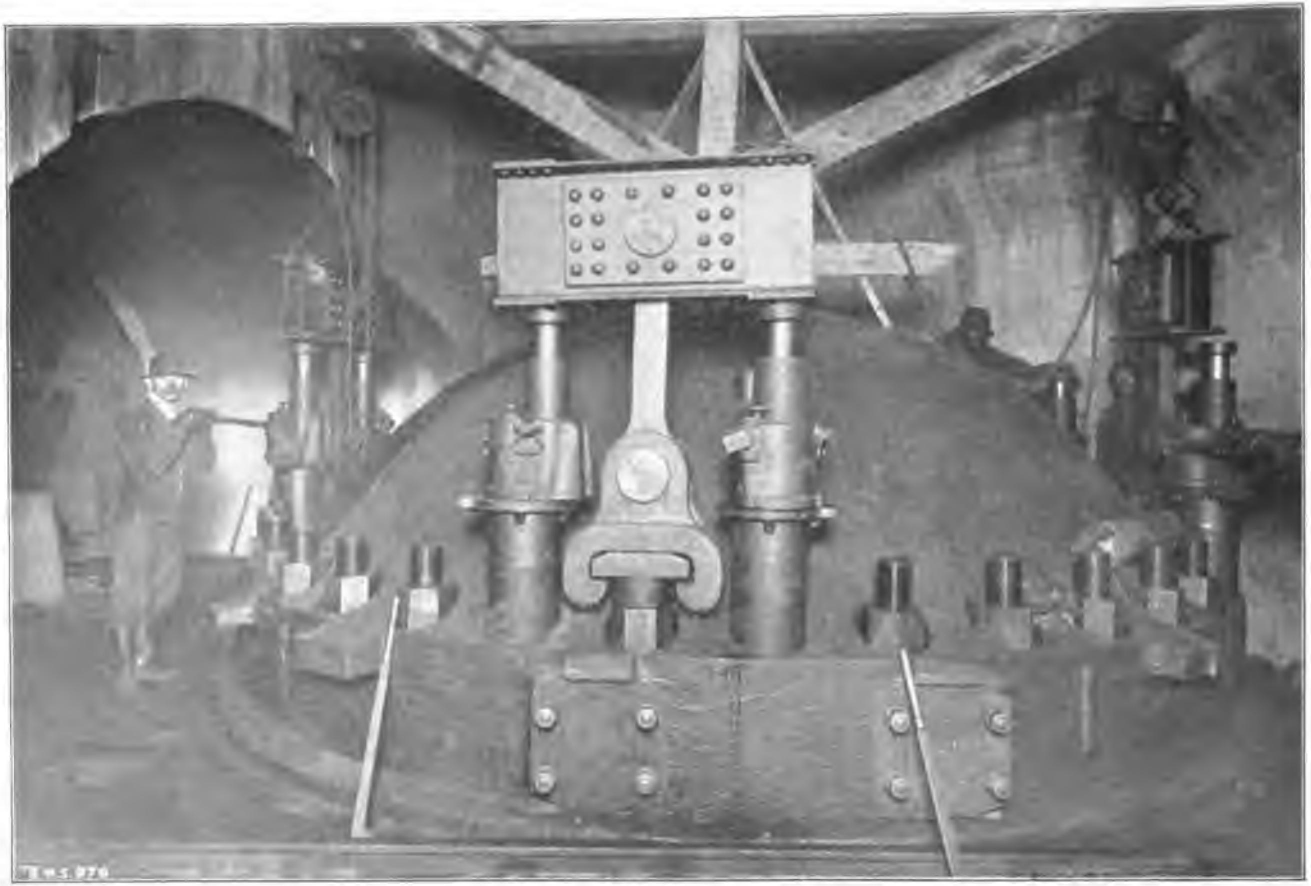
The contract was completed August 31, the final estimate amounting to $3,988,342.28, of which $32,380.47 were estimated during the year.

Valves, Hydraulic Cylinders and Appurtenances

Contract 107—The Chapman Valve Manufacturing Co., Contractor

This contract for valves, hydraulic cylinders and appurtenances includes for this department four 54-inch gate-valves and hydraulic cylinders for the Wallkill blow-off, one 40-inch iron valve and one 40-inch bronze valve with hydraulic cylinders for the Hudson

PLATE 10



CATSKILL AQUEDUCT—Hudson pressure tunnel. Fourteen-foot-diameter cast-steel cap at East or Drainage shaft; note means used in stretching 50-foot anchor-bolts to anticipate deformation under working stress. Contract 90

blow-off, together with the necessary piping, small operating valves and miscellaneous material.

All the work for the Wallkill blow-off and the delivery of materials for the Hudson blow-off were completed in 1913. The installation of the 40-inch blow-off valves was begun at the end of last year and was completed March 4. Final tests were completed May 5.

Gaging and Metering Apparatus

Contract 110—*Builders Iron Foundry, Contractor*

This contract for furnishing and installing gaging, metering and other apparatus for various structures along the aqueduct was awarded January 6, and work was begun January 10. During the year rod gages and gage-well covers were delivered for all divisions. The value of work estimated was $399.66.

Stop Shutters at Gate-Chambers

Agreement 87—*Vulcan Rail and Construction Company, Contractor*

Under this agreement steel shutters were delivered at Rondout, Wallkill and Moodna Downtake chambers for use in connection with hydrostatic tests. They were later installed by employees of the Board. The value of work estimated under this agreement was $2,258.40.

Three Steel Floats

Contract 94—*J. Edward Ogden Company, Contractor*

The work in this department, covering the furnishing and erecting of steel floats at Wallkill and Hudson pressure tunnels, was completed during the year. Erection of the Wallkill float was started in June, and the float finished and tested in November. Work on the assembly of the float for the Hudson tunnel was begun April 2, and the lower 16 feet of the shell were built on the chamber floor and placed in the float recess on May 4, and the float was finally completed on July 6. The value of work estimated under this contract was $9,358.87.

Portion of Catskill Aqueduct Telephone System

Contract 93—*New York Telephone Company, Contractor*

Construction work on this contract, covering a complete telephone transmission line along the aqueduct between Ashokan reservoir and Croton lake, was finished late in 1913, with the exception of

a short gap just south of Garrison tunnel, where aqueduct construction interfered. The final estimate for the whole contract amounted to $51,526.31.

Removal and Re-Erection of Temporary Building

Agreement 84—*D'Olier Centrifugal Pump & Machine Co., Contractor*

Under this agreement the temporary drainage superstructure, erected at Rondout Drainage shaft, was taken down, transported to Storm King and erected with minor changes at the Hudson Drainage chamber. The erection was begun January 19, but work was greatly retarded by severe weather conditions. It was completed March 26, the cost of the work being $4,100.

Jib Crane for Hudson Drainage Chamber

Agreement 88—*J. Edward Ogden Company, Contractor*

This agreement, for furnishing and installing the jib crane for operating the horizontal leg of the discharge system of the unwatering plant at Hudson Drainage chamber, was awarded late last year. The erection was begun May 26 and completed July 3. The cost of the work was $1,619.

Contract 101—Fences at Reservoirs and Along Catskill Aqueduct

District 4—*Abner M. Harper, Inc., Contractor*

The work on this district, which included fencing in the Newburg division and the portion of the Hudson River division west of the river, was practically completed at the end of last year. The remaining work was completed February 12, the final estimate amounting to $48,708.56.

District 5—*The Degnon Contracting Company, Contractor*

Work in this district, which covers wire fencing from the east side of the Hudson river to the south end of the department, was continued to completion December 2. At the end of 1913 the fabrication of posts had been completed, about 65 per cent. had been set, and the work of stringing wires well started. Work was continued through the winter, was suspended in April because aqueduct construction was not sufficiently advanced to permit the setting of posts, and was resumed in September. The final estimate amounted to $22,075.28, the value of the year's work being about $6,500.

UP-KEEP OF STRUCTURES

At the end of 1913 all main-line contracts, except Contracts 2 and 90, were completed. Much of the 1914 work was in connection with the up-keep of the completed portions of the aqueduct and the structures along the same, by the Board's forces. The force of laborers on this work was increased during the early part of the year until a maximum of 35 men was reached, the season's average being 29.

Experimental Use of Aqueduct

In January all small sluice-gates in the aqueduct between the Ashokan Screen chamber and Wallkill blow-off were closed, and a final inspection made to determine that all debris had been removed. In January water was let into the aqueduct from the Ashokan reservoir at the rate of ten million gallons daily, the excess wasting through Wallkill blow-off. This small flow was maintained with a few brief interruptions until May 2, when the Wallkill Blow-off gates were closed to permit filling the aqueduct south to Washington Square siphon. On May 15 the blow-off gates were again opened preparatory to conducting an operating test of the aqueduct for the 24¼ miles of aqueduct north of the blow-off. On May 19 the rate of flow was increased to 50 million gallons daily, and on successive days additional amounts were added until a maximum flow at the rate of 500 million gallons daily was recorded May 30.

The embankments were patrolled for evidences of leakage, and all culverts and gates inspected. Measurements were taken to the water surface in the aqueduct to determine slopes in different stretches and the time for the additions at the Screen chamber to reach points along the line. Observations were also made in terminal shafts at Rondout and Wallkill pressure tunnels. A total of 3,600 million gallons of water, as recorded by the Venturi meter, passed through the aqueduct. In general, the measurements indicated greater slopes of water surface with correspondingly increased velocities and reduced wetted sections than were indicated on the preliminary chart of flows. At other times during the year small amounts of water were run through the aqueduct for filling different sections for hydrostatic test.

Hydrostatic Tests of Aqueduct

Stretches of the cut-and-cover aqueduct were put under hydrostatic test at various times, the outlet seepage measured, and condi-

tions along the outside of the stretch under test carefully noted. The stretches were isolated by closing sluice-gates at steel-pipe-siphon chambers, or installing shutters, furnished under Agreement 87, at pressure-tunnel downtake chambers. Additional tests of Rondout and Wallkill pressure tunnels were conducted, as well as a series of tests of the Moodna-Hudson-Breakneck pressure tunnel. At the end of the year the entire line of the aqueduct had been tested one or more times, except stretches aggregating about 12 miles.

Moodna-Hudson-Breakneck Pressure Tunnel.—One of the most important of the year's operations was the hydrostatic test of this combined structure.

Pumps were removed from the Hudson tunnel in 1913 and the tunnel allowed to fill by inward leakage. At the end of 1913 the Hudson tunnel and the East and West shafts were filled and water had flowed into the greater part of Moodna tunnel. On February 22 Moodna tunnel was full. On about March 1 the rising water had filled Breakneck pressure tunnel and reached Elevation 0 in the East and West shafts. As the interior head grew, the rate of inflow had decreased, and on March 1, it was about 30 gallons per minute. On March 12, with water-level at Elevation 78, the inward leakage was seven gallons per minute, and the elevation of zero leakage was indicated to be approximately 100.

Water for the test was accumulated in the cut-and-cover aqueduct adjoining the Moodna Downtake shaft. A control was established in the Downtake chamber by installing shutters supplemented by timbers; through the timbers which replaced the bottom steel shutter was led a short piece of 14-inch pipe with a gate-valve at its outer end. Access to the valve, for operation when water was flowing upon the floor of the chamber, was given by a plank extending from the concrete ladder to the top shutter. Leakage by or through the shutters was wasted through the 10-inch sluice-gate. Control of the feeding of water for the test was complete and prompt. The leakage determinations were computed from the readings of an electrically-controlled sounding apparatus at the Downtake shaft; check measurements were made for a portion of the time by means of a gage connected to the steel dome in the Hudson Drainage shaft.

The method used on the test was to raise the water-level to a desired point by feeding in at the Downtake shaft and then, cutting off this feed, to measure the rate at which the level fell; the volume of water escaping was then computed from the cross-sections of the shafts. Difficulty was experienced with the first readings because of

the surge; this was very pronounced for half an hour following the shutting-off of the feed-water, the amplitude being, at the start, about 22 inches, and the period 2 minutes and 20 seconds. After experimenting it was decided to take the readings at the low points of the oscillations, and this method was followed throughout the tests.

Water was first turned in on March 12, and the level was raised to Elevation 178 or 100 feet above the starting level. Readings were then taken on the falling surface at intervals for about one hour. More water was then admitted and tests made at Elevations 220 and 270, after which operations were discontinued for the night. On the following day the water-level, which had fallen to 161, was again raised to 269, at which elevation a series of measurements indicated a material reduction in outward leakage as compared with the previous day's determinations at the same level. Other tests were made at successively increased elevations. With water at Elevation 333 considerable leakage developed around the steel cover at the access shaft which was stopped by tightening the holding-down bolts. The water-level was finally raised to Elevation 394.67, invert level at the Breakneck Uptake chamber, and at this time, March 13, first flowed under the Hudson and into the aqueduct east of the river; at this level a leakage of between 1,100 and 1,200 gallons per minute was indicated.

This first filling of the tunnels was done in easy stages in order to test the leakage with the lower internal heads before conditions could be in any way altered by a complete filling. The water was kept at full hight for only 10 minutes and was then allowed to fall. The fall continued until March 17, when at Elevation 97.4 the inward and outward leakage were equal and the water surface became stationary. This is the highest elevation of balanced leakage that was observed. The level of the water in Shaft 8, above the plug, was observed on March 13 but no particular change was noted.

A second and a third complete filling were made on March 19 and March 23. Each time a slight decrease of outward leakage was noted. It was observed that the water-level in Shaft 8 rose, on the former test, to Elevation 44 and, on the latter, a little higher so that it overflowed the top of the observation pipe. After the test of March 23 the water was drawn off through the 40-inch blow-off in the Hudson Drainage chamber; the level dropped from 394 to 5 in slightly over four minutes. This was the first time that the blow-off valves had been operated with the terminal shafts substantially full.

Fillings were made five more times in the period up to April 1,

and outward leakages, as determined by pressure-gage readings at the East shaft on April 1, were materially less than those formerly noted. Particular attention was given to the effect on the water-level in Shaft 8; on one occasion when the tunnel was kept full for six hours water overflowed the observation pipe at a maximum rate of nine gallons per minute.

Between April 3 and April 6 the tunnel was kept continuously full except for two brief periods at night. At the end of this period measurements showed a leakage materially greater than was noted on March 13, when the highest previous results were obtained. This result was confirmed by brief tests on three succeeding days. During the long test Shaft 8 overflowed at a maximum rate of 20.5 gallons per minute. Observations disclosed a tendency for the elevation of balanced leakage to drop, and on April 16 it was at Elevation 67, or 30 feet below the highest recorded determination.

At another test, made on April 18 after the tunnel had been kept full for 26 hours, there was the greatest leakage yet noted. At the time of this filling Shaft 8 overflowed at a maximum rate of 60 gallons per minute, and, for the first time, water was observed coming out of Diamond-Drill Hole 11/C1, an uncased vertical hole located at the outcropping ledge between the West Shore Railroad track and the river, very near the aqueduct line. A pipe was set in the drill hole and the flow roughly determined at 150 gallons per minute.

On a later day, when the tunnel was filled for a brief period, it was established that the head on the Drill Hole 11/C1 equalled the elevation of water surface in Shaft 8, and that when the tunnel was blown off the pressure in the drill hole dropped very quickly to Elevation 24, the water in Shaft 8 following more slowly.

When the tunnel was under pressure, water came through seams in the rock on the surface of the ground north and south of the shaft and also showed on the surface northwest of Shaft 8 to Elevation 97, increasing in volume the longer pressure was maintained. Evidence that water was escaping from the shaft and tunnel near the west side of the river became each day more conclusive.

The last important filling of the tunnel was made May 4, and maintained at the level of Breakneck invert with minor interruptions for 95 hours. Visible evidences of leakage on the surface of the ground, in the woods to the north and along the toe of the Shaft 7 spoil-bank increased with the maintenance of pressure; rough measurements of the visible water indicated 1,400 gallons per min-

ute, or a large per cent. of the increase of leakage after March 13. The observation hole at the top of Shaft 8, which had been plugged and fitted with a pressure-gage, recorded heads up to 87. Drill Hole 11/C1 lost its pressure, probably because the opening of a passage permitted the escape of water to the river. Leakage from the tunnel showed a marked increase each day, finally reaching, on May 8, 3,700 gallons per minute, or at least three times as much as on March 13 under the same head.

Subsequently the following facts were developed:

The point of balanced leakage tended to drop; it was found on May 9 to be at Elevation 42, and reached a minimum at 20, late in July. It was proved that there were no cracks in the access shaft permitting the water to escape.

Pressure from the tunnel reached Drill Hole 11/C1 below Elevation —190, and there was a free passage from the hole to the river above —30; these facts were established by packer tests.

The water-level in Shaft 8 was very sensitive to even small heads in the tunnel; it would overflow its observation pipe, at Elevation 44, with water-level at Elevation 125 in the tunnel.

A test was made at Shaft 8 by pumping out the part of it above the plug through the observation hole, by a deep-well pump. The head in the tunnel was varied from 5 to full hight and measurement made of the rate of pumping necessary to keep the water surface in the shaft at a constant elevation of —117; also observations were made at the drill hole and upon the surface leaks in the vicinity. The following conclusions were reached:

Surface leaks about Shaft 8 were the result of pressure in the tunnel. Pressures in the drill hole followed the pressure in the tunnel, and were not influenced by conditions in the top of Shaft 8.

The leakage into Shaft 8 above the plug was not through a single concentrated opening around or through the plug, but entered through a number of small openings of indefinite location.

There was considerable storage of water between the tunnel and the upper part of the shaft; the effect of the river-head could not be determined. The continued application of pressure to the tunnel appeared to permanently open the passages into Shaft 8.

The behavior of the water-level in the construction shafts above their plugs was observed from time to time during the period in which the tunnel was undergoing the hydrostatic tests. Indications of slight effect from tunnel pressure were noted at Shafts 3, 4 and 6, but not at the others.

A last filling of the tunnel was made on July 9 and 10 in connection with pumping tests at Shaft 8. At this time measurements of leakage showed a slight increase over those of May 8.

Unwatering the pressure tunnel was done with the pumping equipment furnished under Contract 58, which was shipped to the Hudson Drainage chamber following the erection of the temporary superstructure over the chamber.

In addition to the original plant, the following were provided and installed: A 125-volt 25-kilowatt direct-current General Electric gasoline generating set to provide light in the pump float in case of interruption to the main power circuits; a direct-current motor-driven Bury compressor to provide ventilation in the pump float during operation, and gasoline hoist to serve as an auxiliary means of access to the shaft in case of failure of the electric power. The float was completed under the provisions of Contract 94, August 1.

The pumps, which had been repaired during the winter, were immediately placed in the float. The shaft cover was removed by an outfit of eight 60-ton hydraulic jacks, purchased for this and subsequent use. The load was taken off the holding-down bolts in 60 set-ups by taking the bolts alternately and removing one-half the load at a time. The whole operation of unstressing bolts, jacking up and moving the cover into the recess occupied 15 hours, with a force of 10 men. The float was launched August 16, water being furnished through the control valve at the Moodna Downtake shaft supplemented by a supply pumped from the Hudson. The motors were placed, wiring completed and the pumps tested, and pumping was begun August 29. An 11-hour run sufficed to empty the shaft to the arch of Moodna tunnel with only one pump, September 7. After this, with both pumps working, the unwatering proceeded more rapidly, and Moodna tunnel was completely emptied by September 12. Due to the high rate of leakage into the tunnel, the float rose so rapidly that it was impracticable to add pipes at the East shaft with the jib-crane equipment as originally provided, as there would be great danger of a pipe binding at the top before it could be connected properly, and breaking or seriously damaging the crane. Alterations were made, permitting unwatering to proceed to Elevation —450 (Pipe 23). Beginning with the unwatering of Moodna tunnel proper, both pumps were operated in parallel a total of 153 hours, until the tunnel was completely emptied.

The unwatering of the Hudson shafts then proceeded with one pump. The discharge under the increased head had diminished to

such an extent that both pumps were started in parallel. Trouble was encountered with Pump 2, and it was decided to postpone the unwatering of the Hudson tunnel. The float was allowed to rise to Pipe 14 (just below Moodna tunnel at Shaft 8), and remained there until operations under Contract 160, for Moodna Siphon supplementary shaft and tunnel, required the unwatering to a greater depth. When Pipe 14 was reached the storage in Moodna behind the Shaft 7 dam was pumped and the valve in the dam left open. Intermittent pumping was continued with the float in this position until interruption of the power service on December 7 by a severe ice storm forced the removal of Pipes 13 and 14. Moodna tunnel was used for storage until December 15, when Pipe 13 was replaced and kept in line until the end of the year by intermittent pumping.

Power for the unwatering was furnished by the Central Hudson Gas & Electric Company, current being transmitted partly over the Board's telephone poles erected under Contract 93. Power consumed to date was about 350,000 kilowatt-hours.

For the inspection of the Moodna tunnel, a light timber headframe was erected at Shaft 1, and a rented double-drum hoist with cables and sheave set up. A light bucket and an 11-foot steel boat for use in the siphon were also obtained. Steam was furnished from a 40-horse-power portable locomotive boiler. The boat was lowered into the tunnel on August 31, when pumping had progressed sufficiently, and inspections were made from time to time up to September 9. These inspections indicated that while inward leakage was undoubtedly greater than before filling the tunnel, there was nothing approximating a break or rupture of the lining west of Shaft 7 which could in any way account for the increased leakages observed when the tunnel was under hydrostatic test earlier in the year. The inspection equipment was moved to Shaft 7 and set up. Water in Moodna tunnel was lowered sufficiently to permit an inspection from Shaft 7 to Shaft 8 on September 11. Heavy inward leakage was noted in Shaft 8 upraise at the junction with Moodna tunnel, as well as heavy leakage in Moodna tunnel at Shaft 8, decreasing rapidly toward Shaft 7.

Upon completion of the Moodna Tunnel unwatering a timber dam was installed in the grooves at the foot of Shaft 7 for controlling the leakage into Moodna tunnel while the unwatering of the Hudson tunnel was in progress. A pipe with a 14-inch valve served to control the flow through the dam.

With the unwatering of Moodna tunnel a more detailed inspec-

tion was made west of Shaft 7. Measurements indicated an inflow of 210 gallons per minute, which compares with an inflow of 80 gallons per minute observed late in 1913, when the last previous measurements were made. This inspection indicated that the increased inflow was general, and apparently followed enlarged openings in transverse joints and along key, side-wall and invert joints.

A temporary hoisting equipment was installed for use in inspection of Shaft 8 below Moodna tunnel. The inspection was made September 26 to Elevation —450, there being no evidences of cracks in the shaft between Moodna Tunnel invert and the above point.

Measurements showed the total inflow at Elevation —230, the invert elevation at Moodna tunnel, to be about 800 gallons per minute, of which about 500 gallons per minute were coming from cracks between Shafts 7 and 8, and in the Shaft 8 upraise.

These cracks were calked with lead wire under arrangement with the Mason and Hanger Company, and the inflow cut down to not over 50 gallons per minute. Some calking was also done west of Shaft 7, and the inflow in Moodna tunnel reduced to 140 gallons per minute.

A pressure-gage attached to a pipe set in a crack in the Shaft 8 upraise recorded a pressure of 85 pounds, on completion of the above calking. This pressure showed the head to be substantially equal to the river level.

Aqueduct Interior

Early in the year a careful inspection was made of the interior of completed cut-and-cover aqueduct, necessary cleaning out was done, and a few expansion joints calked. The placing of marking tiles was completed at the same time. In October and November, after the unwatering of Moodna siphon, calking of leaks and cracks was done by Mason and Hanger Company. Rondout, Wallkill and Hudson pressure tunnels were filled with water during the entire year.

Embankments

In general the aqueduct embankments came through the winter in excellent condition, largely because of the fine sod secured during 1913. An exception was on the Wallkill Blow-off embankment, where seeding was done too late in 1913 to produce good grass. Here an extensive refilling, grading and seeding operation was necessary. In general, repairs were limited to filling small wash-

outs, but at some points it was necessary to restore the top of the embankment because of settlement, and to construct berms to secure the permanency of the slopes. Seeding was done where necessary, and generally consisted of patching thin places. The work done in the fall showed poor results because of the drought. Grass, weeds and bushes were cut and trimmed whenever necessary, generally by hand, although hired mowing machines were used where conditions were favorable. The embankments, grassing, etc., throughout the department were in generally good condition at the end of the year.

Wallkill Blow-Off

The bottom of the open channel at the outlet end of the blow-off was badly eroded by the heavy discharge of water during the experimental use of the aqueduct in May. It was repaired by cleaning out and removing loose and shattered rock below the invert level, and filling same with concrete in which were bedded large quantities of sound stone. The surface was carefully screeded and shaped to meet the open end of the circular conduit.

Appurtenances—Apparatus

Early in the year a small force operated all sluice and blow-off gates, finding them in generally good condition. Necessary small repairs were made, mainly by the Board's forces. Wedge-locking studs in all 5-foot by 13-foot sluice-gates were replaced by the Coldwell-Willcox Company under Contract 44. The frames of these gates were bricked up by Board's forces. Sluice-gates in siphon chambers east of the Hudson river were cleaned and painted. Protective housings were maintained over sluice-gate operating stands, except where permanent superstructures had been finished.

Culverts and Drainage Ditches

Culverts and drainage ditches were cleaned out and deepened where necessary. A new 12-inch tile-drain was laid at the crossing of the Minnewaska road and the aqueduct in order to take care of springy conditions in the road, and 500 feet of 4-inch agricultural tile were laid just west of the aqueduct north of Poor Farm brook to remove collected surface-water. A new road culvert was built under the highway just south of Indian Brook siphon. In certain locations where culverts filled up with silt and mud, cleaning was necessary twice. In general, however, the growth of vegetation around culvert inlets was sufficient to prevent undue washing.

Buildings

Late in the year 15 buildings, formerly used as section offices, locker houses, etc., along the line, to be used in connection with maintenance operations, were repaired and painted.

Fences

Settlement of embankments and right-of-way fills necessitated considerable adjustment of steel gates to permit closing and latching. Adjustments were made by straightening up posts or inserting washers in the upper hinge fastening. Chains and locks were installed on right-of-way gates to prevent opening by unauthorized persons, and to insure the keeping of live stock off the aqueduct. Re-alinement of fence was necessary at a few rights-of-way because of settlement, and near the outlet end of Wallkill blow-off about 300 feet of fence were reset in a new position because of damage when the ice went out of the river in the spring. Late in the year, work was begun on cleaning and painting posts and guard-rails, and about 100 steel gates were touched up where rust had appeared.

Telephone Line

This line, constructed by the Board, was used by means of portable sets early in the year in connection with the hydrostatic test of Moodna-Hudson pressure tunnel. In May, permanent instruments were installed in the department office, as were also temporary instruments at three points along the aqueduct. A portable telephone set was very useful in establishing a connection from any point on the line. The poles were numbered consecutively from the Ashokan Screen chamber to the north end of the Peekskill division, and will be continued farther south. The maintenance of the line is being done by the New York Telephone Company under agreement.

Miscellaneous

Bench-mark elevations were established in manholes, siphon chambers and on culvert head-walls. Center-line monuments were set along the aqueduct and culverts, manholes and gates were numbered to facilitate keeping of records. Final stations were stencilled on north posts of right-of-way crossings.

In April, 2,080 young pine trees from the Reservoir Department nurseries were set out on the aqueduct right-of-way, and at spoil-banks in the Esopus and Wallkill divisions. About 60 per cent. of the total planting survived the fall drought.

SOUTHERN AQUEDUCT DEPARTMENT

FRANK E. WINSOR, *Department Engineer*

The Southern Aqueduct department covers that portion of the Catskill aqueduct extending from a point about four miles north of New Croton dam to the New York City boundary, a distance of 31.2 miles. It is also charged with the supervision of the construction of the Kensico and Hill View reservoirs.

ORGANIZATION

DIVISIONS AND EMPLOYEES

The organization of the department was the same as last year, except that the White Plains division was disbanded, as were also many of the sections, due to the completion of contracts. Ernest W. Clarke, Division Engineer, White Plains division, separated from the force March 31.

EMPLOYEES IN SOUTHERN AQUEDUCT DEPARTMENT—1914

	JANUARY 1	DECEMBER 31	MAXIMUM	MINIMUM
Engineers and clerks......	133	108	141	108
Laborers	55	44	58	43

EXECUTIVE DIVISION

William W. Peabody, *Division Engineer,* White Plains

The work of the division consisted of the preparation of working drawings for detail work along the aqueduct; compiling partial and final estimates; making studies and computations for proposed highway routes around Kensico reservoir in substitution for abandoned roads, and keeping records of progress of all contract work.

CROTON DIVISION

Charles M. Clark, *Division Engineer,* Pleasantville

This division supervised the construction under a portion of Contract 55 and a portion of Contract 101 and attended to the up-keep of structures.

KENSICO DIVISION

Wilson Fitch Smith, *Division Engineer,* Valhalla

This division is in charge of the construction of the Kensico reservoir and appurtenant structures under Contract 9; portions

of the aqueduct and effluent structures under Contract 55; the clearing of chestnut growth under Contract 142, and wire fencing under a portion of Contract 101; the sanitary supervision of the watershed within the reservoir taking; reforestation work, and up-keep of the aqueduct and appurtenant structures.

WHITE PLAINS DIVISION

William W. Peabody, *Division Engineer,* White Plains

Contract work was nearly completed last year and the division organization was disbanded at the end of last year. The supervision of the remaining work, comprising Contract 53 for a portion of the aqueduct, part of Contract 79 for the Elmsford blow-off, part of Contract 101 for wire fencing, and maintenance work, was taken over directly by the department office.

HILL VIEW DIVISION

Charles E. Wells, *Division Engineer,* Yonkers

The work of this division comprised the construction of the Yonkers pressure tunnel under Contract 54, Hill View reservoir under Contract 30, and Bryn Mawr blow-off under a portion of Contract 79.

OFFICES

The department and Executive Division offices were continued in the Realty building, Railroad avenue, White Plains, occupying seven rooms, two vaults and the basement.

The Croton Division office was moved on the expiration of the lease on April 30, to the former Board of Water Supply Police headquarters, on Bedford road, Pleasantville, immediately adjoining the aqueduct. Offices of Sections 2, 4 and 5 were used as headquarters for up-keep work after the completion of the contract work.

Offices for the Kensico division were continued as in 1913 in Valhalla. Section 2 offices were continued until August 31, on which date the premises were vacated.

The Board's building on Tarrytown road in Elmsford was continued in use by the White Plains Division office, as well as Section 2 and Section 4 offices.

The Hill View Division office in Yonkers was continued in use as in 1913, and the Section 1 office was occupied until December.

CONSTRUCTION

Croton Division

THREE STEEL FLOATS

Contract 94—J. Edward Ogden Company, Contractor

One of the three steel floats provided for in this contract is included in this department. It is to be used in the Downtake shaft of the Croton Lake pressure tunnel. The float was delivered in July and erection was begun November 27 but not completed at the end of the year.

GATE, CONTROLLING AND OTHER VALVES AND SLUICE-GATES

Contract 104—Coffin Valve Company, Contractor

This contract was awarded February 10. The portion in this department covers the furnishing, delivering and installing of a 5-foot by 5-foot sluice-gate with operating stand in the Downtake chamber of Croton Lake pressure tunnel. The gate and the mechanism were delivered on December 11.

STOP SHUTTERS AT GATE-CHAMBERS

Agreement 87—Vulcan Rail and Construction Company, Contractor

The stop shutters, frame, hoists and other apparatus for the Downtake chamber of Croton Lake pressure tunnel were delivered on March 20, completing the work under the agreement in this department.

The frame was erected and the shutters were lowered into the six sets of stop-plank grooves constructed in the walls of the chamber by the Board's employees.

MILLWOOD, SARLES, HARLEM RAILROAD, PLEASANTVILLE AND REYNOLDS HILL TUNNELS

Contract 55—Rinehart & Dennis Co., Contractor

(See also Kensico Division)

The portion of this contract in the Croton division comprises 2.8 miles of cut-and-cover, 2.9 miles of grade tunnel and 0.2 mile of pressure aqueduct.

At the beginning of the year 98 feet of invert and 146 feet of arch of the cut-and-cover aqueduct, 30 feet of invert in Millwood tunnel and 1,033 feet of arch in Reynolds Hill tunnel remained to be completed. The contract was completed October 1, the final

estimate, including the work in the Kensico division, amounting to $4,370,363.90.

Camp Bolton was in use in the spring and early summer but by July 1 it was abandoned and some of the buildings removed, those remaining being left by consent of the owners of the land. Camp Fisher was occupied until June 1 when it was abandoned, all buildings except two being removed. Camp Coleman was continued in use until the completion of the contract, at which time all structures had been removed and the grounds satisfactorily regraded.

The two chemical-dosing plants for treating the streams and tunnel drainage at the north portal of Millwood tunnel, and between Millwood and Sarles tunnels, were in operation until contract work was completed.

The only plant in use on the northerly portion of the contract was that used for crushing stone and mixing and conveying concrete, situated at the south portal of Millwood tunnel, consisting of three small jaw crushers; three portable horizontal boilers with engines; bucket elevators; two Stevenson sand-rolls; bins for sand and stone; a No. 4 Ransome mixer and engine, and a 1,200-gallon water-tank, with teams, wagons and scrapers used for completing refill and placing top-soil. At the southerly end of the contract the concreting plant near the south portal of Reynolds Hill tunnel was continued in use. This plant included a Ransome mixer with engine and boiler; bins and screens; a stiff-leg derrick; a Brownhoist crane; dump, box and sand cars, and six bottom-dump buckets. In addition to the concrete-mixing plant, teams, wagons and scrapers were used for the completion of the aqueduct embankment and final grading.

On the cut-and-cover at the northerly end of the contract, excavation of rock and grading for rights-of-way were continued with a small force during the winter. Concreting was completed January 24. Refilling was then begun and all embankment, refill, top-soiling and cleaning up were completed July 15. At the southerly end of the contract the only work in progress was grading at the north and south portals of Reynolds Hill tunnel, the completion of the paving, grading, and placing of top-soil at the latter portal and refilling over the aqueduct south of Reynolds Hill tunnel and for the access road to the Influent weir and chamber the material for which was loaded onto dump-cars by a steam shovel working along the easterly side of the spoil-bank. All of this work was completed by the middle of May.

Concreting Millwood tunnel was completed last year except for 30 feet of invert at the south portal left for use as a sump. This section was concreted March 28, being the last invert placed in this division. Grouting was begun in March at the sealing bays, 30 feet in length, at the north and south portals, and in the timbered section about 1,390 feet from the north portal, where the slip occurred in April, 1911.

Sarles Tunnel arch was grouted in March at the sealing bays, 30 feet in length, at the north and south portals, and the tunnel cleaned out.

Grouting at the south sealing bay of Harlem Railroad tunnel and the north sealing bay of Pleasantville tunnel, both 30 feet in length, was done in March and the tunnels cleaned out.

In Reynolds Hill tunnel 1,897 feet of arch and side walls remained to be placed at the beginning of the year. This work was completed by January 27, the methods in use during 1913 being followed. The high-line was then removed and the tunnel cleaned out, and during May the sealing bays, 30 and 42 feet long, at the north and south portals, respectively, were grouted.

On January 30 all water was drawn from the Pleasantville Village reservoir, which had been built in 1910 by the contractor to supply the village with water. During the next four days the contractor removed over 500 cubic yards of muck which had been washed down from the contract work and deposited at the upper end of the reservoir. The supply for the village was pumped during the greater part of 1913 and the beginning of 1914 from the southerly barrel of the double-barrel siphon culvert about 1,850 feet north of Reynolds Hill tunnel.

On February 9 the contractor ceased pumping for the village supply, the gates of the dam having been closed on February 8, and after unsuccessful attempts to pump out the culvert in order that the inlet pipes might be sealed, a diver entered the culvert on August 21 and inserted iron plugs in the two 4-inch pipes. The culvert was then pumped out and the recess in the side wall of the culvert into which the 4-inch pipes opened was filled with concrete. During the succeeding week the pumps and the enclosing houses were removed and paving and cleaning up about the culvert were completed.

The contractor's average daily force including the Kensico division was 135 men and the maximum was 309 men.

Kensico Division

LAKEHURST, DIKE AND KENSICO TUNNELS, INFLUENT, EFFLUENT AND AERATION WORKS AND KENSICO DIKE

Contract 55—(See also Croton Division)

This portion of the contract includes about 250 feet of cut-and-cover aqueduct, 0.8 mile of grade tunnel and 2.7 miles of pressure aqueduct, including the By-pass aqueduct around Kensico reservoir, together with the Influent chamber and weir adjacent to the south end of the Croton division, the Upper Effluent chamber and Connecting channel, the Lower Effluent chamber, the Aeration works, the Kensico dike and other structures.

At the beginning of the year the only important work remaining to be done was concreting at the Influent weir and Influent chamber, which work was completed during the year. The contract was completed October 1, the final estimate, including the work in the Croton division, amounting to $4,370,363.90.

Camp Columbus was continued in use until the completion of the contract, the camp buildings having been previously removed from time to time. The hospital was maintained until the completion of the work, when the building was demolished and the cesspools chlorinated and refilled.

Early in July the Ingersoll-Rand compressor, two fire-tube boilers and the 30-kilowatt alternating-current generator used for lighting the camp were removed, all piping was torn up and hauled to the yard, and the site of the plant, being below the level of the full reservoir, was graded so that it would drain freely. About 7½ miles of tracks were removed and regrading done. On January 22 dismantling of the stone-crushing plant was begun, but final cleaning up did not take place until early in August. The concrete mixing plant at the Aeration basin was dismantled early in the year and the site was graded, top-soiled and grassed, the small amount of concrete used being mixed by hand.

The work on the Influent gate-chamber and weir, which included the placing of a section of coping over the weir and the floor panels of the chamber, was completed in April, at which time the pipe-railing was placed on the coping and the earth surrounding the chamber and weir was graded. A channel about 20 feet wide was excavated by a steam shovel from the southerly end of the weir eastward to the brook bed, the excavated material being partly placed as back-fill at the weir and partly for the access road to the

gate-chamber. In the Influent chamber, the structural-steel support for the operating mechanisms was erected and the three 5-foot by 13-foot sluice-gates set and grouted, the operating mechanisms were installed and the gates tested. Riprap was placed around the blow-off and to the south of the chamber and north of the weir, and a culvert was built under the road north of the weir.

On the By-pass aqueduct the work consisted of final grading, placing of riprap on the embankment slopes over culverts and miscellaneous work at the manhole at the north portal of Lakehurst tunnel.

Miscellaneous work at the Effluent aqueduct consisted of final grading, cleaning out the drain under the aqueduct, cleaning the aqueduct and placing boat-hole covers.

The only work on Lakehurst tunnel was grouting, which was begun May 22 and finished June 29. When the tunnel was excavated, dry packing was placed for certain stretches and when the concrete lining was placed this packing was not removed but grout pipes were placed through the lagging at the springing-line of the arch and at a level five feet above the springing-line. The first work of grouting consisted of the filling of the dry packing at the haunches to the level of the upper row of pipes, the grout being mixed of 1 part cement, 1 part sand and 2½ parts water. The north portal of the tunnel was sealed to the rock for a distance of 120 feet and the south portal for 189 feet. All materials were brought into the tunnel through the manhole at the north end and work was carried on by two shifts using a Caniff tank grouting machine, the air supply being furnished from the compressor near the northerly end of the By-pass aqueduct. In all 480 cubic yards of grout were placed, using 1,017 barrels of cement.

In the Dike tunnel grouting of the sealing bays at both portals was completed June 24. Connections were made to 26 grout pipes and 85.3 cubic yards of grout were used. In this, as in the other tunnels in the division, lead wool was used in calking at points which showed leakage after nearby holes had been grouted to refusal. Measurements of leakage into Dike tunnel indicated that most of the water reached the underdrain without passing through the tunnel waterway. It was concluded that the tunnel underdrain, which consists of 18-inch vitrified pipe, did not have tight joints. Holes were cut in the invert of the tunnel and the drain opened for inspection. Examination of the drain with an automobile

search-light and with candles floated through on rafts seemed to prove that many of the joints were admitting water. A hole was excavated in the floor of the Lower Effluent gate-chamber and a 14-inch gate-valve with an extension stem to the top of the chamber was installed, so that with the valve closed no water will escape from the tunnel through the drain. After the underdrain had been thoroughly cleaned the three inspection holes were sealed.

Kensico tunnel was completed except for grouting which was begun April 14 using a Douglas hand-pump. A relatively thick grout was used for the initial grouting and whenever the grout from one hole appeared at another hole, the valve at the latter hole was closed and not opened until the grout had obtained its initial set; the valve was then taken off and any mortar found in the pipe was immediately removed. After the entire length of seal had been traversed it was re-traversed and a thin mixture of neat cement grout forced into all grout holes. The grouting work was carried on by two shifts; connection was made to 43 grout pipes and 131 cubic yards of grout were used, the work being completed on May 30.

At the Inlet channel the work consisted of deepening the rock cut and the removal of material which had sloughed into the channel.

The work on the Upper Effluent chamber consisted of the placing of back-fill behind the wing-walls, construction of the paved slopes, casting of reinforced-concrete covers, and reinforcing of the gate frames by masonry struts on both sides of each frame. In the latter work the frames were braced at the floor by struts of steel rail resting in hitches cut in the floor and overlaid with a section of new concrete floor. The Lower Effluent chamber was completed at the beginning of the year.

At the Aeration basin the remaining work of placing manhole covers, repairing bronze nozzle bases, cleaning out the vitrified nozzle pipes, placing the grating over the collecting conduit and final cleaning up was done.

The work at the Kensico dike consisted of the grading and placing of top-soil on the area between the dike and the Aeration basin, the surfacing of roads, the building of catch-basins and head-walls, grassing on graded areas and cleaning up.

The sewer system at the Lower Effluent chamber, the various

PLATE 11

KENSICO RESERVOIR—Lower Effluent Gate-Chamber substructure with gate-operating mechanisms at floor level. Kensico Aeration basin between it and Screen Chamber substructure in background beyond road. Contract 55

roads, and the gaps in the boundary walls which had been left open to provide for access, were completed.

KENSICO DAM AND APPURTENANT WORKS

Contract 9—H. S. Kerbaugh, Inc., Contractor

The work under this contract comprises the construction of the Kensico dam and appurtenances for Kensico reservoir and of the Substitute Supply works furnishing water to the Williamsbridge district, in place of Kensico lake, emptied for the construction of the dam, and the relocation of highways around the reservoir to replace those to be submerged.

At the beginning of the year the greater part of the excavation for the main portion of the dam had been completed and about 35 per cent. of the masonry had been placed. At the end of the year the excavation was practically completed except a portion on the East hill, about 89 per cent. of the total volume of masonry in the dam had been placed, and a large portion of the terrace-wall foundation had been built; about 77 per cent. of the amount of the contract, as measured by the partial estimates for payment, was completed.

Camp Kensico remained as in 1913, consisting of twenty 2-family houses, twenty-four 24-man houses, and general and isolation hospitals. In addition to these, 13 buildings within the reservoir taking were in use by the contractor. The maximum population of the camp during the year was attained in September, being 788 persons, of whom 615 were adult males. At this time 1,000 men living outside of the camp were also employed.

The brick and concrete incinerator was in use throughout the year, all refuse and other waste being collected and burned.

The contractor's storage yard and the siding connected with the New York Central and Hudson River Railroad were continued in use. This yard contained storage space for coal, a rotary bag shaker, ice-house, storehouses, blacksmith's shop, two stables and a granary. A guy derrick with 80-foot boom and provided with a clam-shell bucket was used at the yard in unloading cars.

The machine and carpenter shop was maintained in the steel-skeleton building north of the cableway towers at the east end of the dam. The storehouse, 100 feet long and 20 feet wide, a concrete building 50 feet long and 15 feet wide used as an oil house, and two small corrugated-iron houses used by electricians, were also

occupied as in 1913. Two stiff-leg derricks located near the cableways were used to assist in the handling and repair of heavy plant.

The use of electricity as a principal source of motive power was continued, current being furnished at a potential of 45,000 volts. The current at the high potential was stepped down to 2,200 volts at the power-house near the east end of the dam and at this voltage was transmitted to the field transformers, where it was further reduced to 440, 220, and 110 volts as required.

In addition to the electrical installation two Laidlaw-Dunn-Gordon compressors, each capable of delivering 1,500 cubic feet of free air per minute, were located in the power-house and were belt-driven from two 300-horse-power induction motors. Supplementing this air-plant and located in the contractor's yard was an Ingersoll-Sergeant compressor capable of delivering 1,500 cubic feet of free air per minute, this compressor being operated by two steam-boilers.

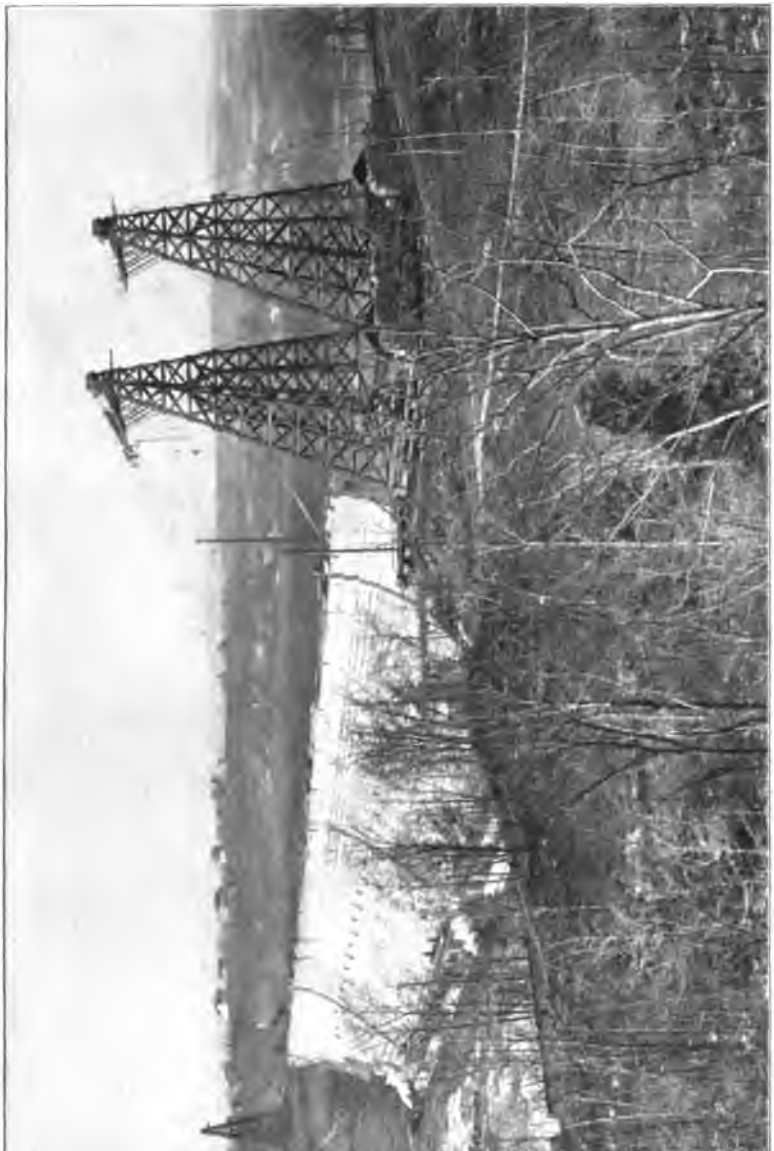
Very few changes were made in the main-line railroad trackage during the year. A spur-track was added at the up-stream face of the dam during the year, this spur line comprising a switchback from the East hill descending to the bed of the old lake and thence over a trestle giving immediate access to about 900 linear feet of the vertical face of the dam. A single spur-track connected with each concrete mixer at the dam, thus allowing cement to be handled in the original car directly to the mixers.

A spur-track was laid along the entire length of the down-stream toe of the dam, and this track was used at the beginning of the year in supplying cyclopean stone to the travelers and derricks. At the end of the year the trackage in use approximated 19 miles in length.

The long face developed on the west side of the North hill, which was worked by a steam shovel for the crushing plant last year, was cleaned up early this year by derricks, and quarrying for large stone was begun at its south end. Excavation in this face was continued with small local blasts producing a great number of large fragments suitable for dimension stone and cyclopean stone. The need for the development of a dimension-stone quarry led to the opening up of the East hill at a low level. A trench 5 feet wide, 25 feet deep and 100 feet long was sunk and quarrying operations were begun on both faces, working northward and southward, excellent stone suitable for the largest dimension stones being developed.

Material for crushed stone was obtained from the north and

PLATE 12



KENSICO DAM—View northwest from East Hill. Contract 9

south hills. The largest blast in this quarry was fired March 21, involving 142 holes spaced about 20 feet apart and ranging in depth from 35 feet to 52 feet. These holes were loaded with 32½ tons of dynamite. The springing and loading required two months' time, and it was estimated that this blast broke up 117,000 cubic yards of rock. The excavated rock furnished about 340,000 cubic yards of crushed stone, 120,000 cubic yards of cyclopean stone, 9,000 cubic yards of dimension stone and 70,000 cubic yards of crusher dust.

Stone roughly cut to dimensions was brought on flat cars from the quarry to the stone-cutting yard, where it was handled by a 25-ton Shaw electric crane. In the yard 9 Oldham surfacing machines and 50 plug drilling machines were used, and 30 plug drilling machines were in use on dimension stone at the quarry. Stone cut in this yard was immediately hauled to the site of the dam and piled on two areas, one north and one south of the North Castle road. The force employed on stone cutting was gradually increased to a maximum of 61 in the latter part of the season.

The crushing plant was entirely overhauled and remodeled during the winter of 1913-1914. As originally built, the plant consisted of a 60-inch by 84-inch jaw crusher to which all material was delivered by train, the entire product of this crusher passing to a 36-inch by 72-inch jaw crusher and from the latter into a pit from which it was raised to a revolving screen by a steel double-chain continuous bucket elevator with end pulleys 80 feet apart on centers. Rejections from this screen passed through 60-inch rolls and dropped into the pit. As in 1913, the weakest part of this equipment was the elevator, which, with the large screens, was considered to be overloaded. This year an intermediate rotary screen, conveyor and gyratory crusher were added to relieve the overloading on some parts, the steel elevator was replaced by a rubber belt 36 inches wide with steel buckets, and the main rotary screen was completely rebuilt. A 4-foot by 6-foot tunnel to the bottom of the main elevator pit was excavated for the purpose of drainage and to allow the cleaning out of the pit.

As remodeled the plant consisted of two jaw crushers, 60-inch by 84-inch and 36-inch by 72-inch, one rope-driven from a 300-horse-power induction motor and the other belt-driven from a 150-horse-power induction motor, the product from the second crusher being lifted by the 36-inch rubber belt with steel carrying buckets and delivered to an intermediate rotary screen 60 inches in diameter and 10 feet long, having 5-inch perforations. Stone passing this

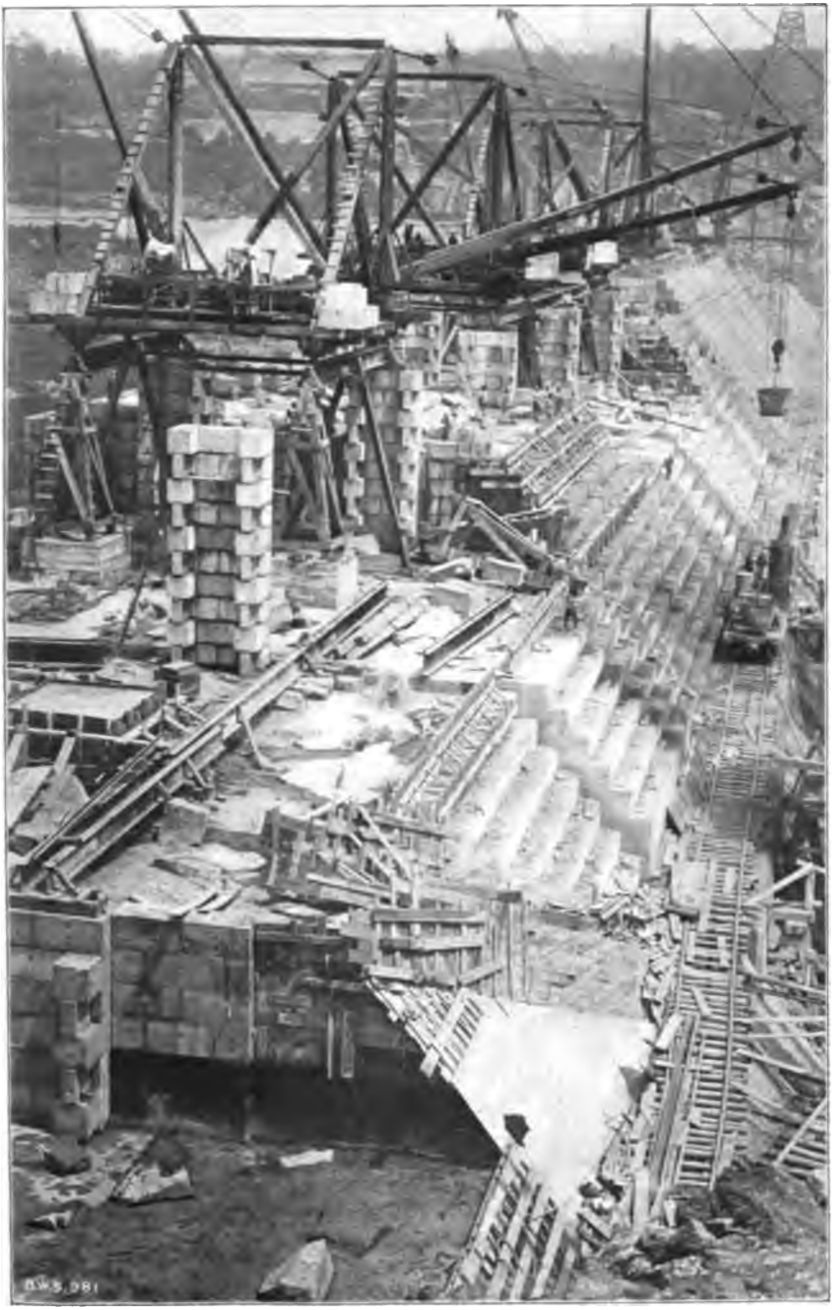
screen fell to the pit, and rejections were delivered to a No. 8 McCully gyratory crusher driven by 150-horse-power induction motor, which also delivered to the pit. Crushed stone was taken from the pit, raised by the main belt-and-bucket conveyor to the main rotary screen, 8 feet in diameter and 30 feet long, with 3-inch perforations, the rejections from this screen passing by gravity to a pair of 30-inch by 60-inch rolls operated by a 100-horse-power belt-connected motor, one of the rolls being corrugated and set to reduce the stone to 2½ inches in size. The plant as remodeled did satisfactory work. The crushed stone was carried by a belt conveyor 30 inches wide from the revolving screen to the bins, where it was delivered to a distributing belt of the same width, 215 feet long, and running the length of the storage bins which discharged into the bins. The stone bin, having a capacity of 7,280 cubic yards, and the dust bin with a capacity of 1,200 cubic yards remained the same as last year. No surplus of crushed stone could be accumulated as the stone was used for concrete as fast as it could be produced, and it was necessary to operate the steam shovels and the crushing plant on a two shifts per day basis during the greater part of the year. The average output of the plant while on such basis was approximately 2,400 cubic yards of crushed stone per day.

Practically all of the sand used in the dam and in the block yard this year was procured from the pit at the northeast end of Rye lake. A 70-ton steam shovel loaded the sand into 25-yard cars, which were filled about two-thirds full, hauled to the crushing plant where they were completely filled with crusher dust, and then run to the mixing plants.

The block yard remained the same as in 1913. Five tracks ran the entire length of the yard, in two groups of three and two tracks respectively. The arrangement and operation of the electrically-operated traveling mixing plant were not changed except that the cement storehouse on the traveler was seldom used, it being the practice to make the cement car fast to the traveler and to operate them as a unit. Immediately outside the service track on the west side of the yard was an elevated bin with a capacity of 300 cubic yards, from which aggregate could be placed directly in buckets on the service trains and hauled to the traveling mixer wherever located, this storage bin being filled from above by trains operating on an inclined trestle.

The block forms, most of which were steel consisting of five built-up parts, were used as in 1913 with the addition of some wooden forms for special blocks.

PLATE 13



KENSICO DAM—Elevated traveling stiff-leg derricks whose tracks rest on blocks forming facing of expansion joints. Contract 9

Two cableways, three separate mixing plants, a number of shuttle concrete cars, a system of traveling derricks and a number of guy derricks were in use throughout the construction season on the site of the dam. The cableways were used only to assist the main plant as in 1913. As the masonry rose in the dam the use of the cableways lessened and they were moved down-stream to clear the derricks.

At the beginning of the year work was actively begun on the remodeling of the concrete plant, the trestle at the easterly end of the dam was removed and that portion of the dam partially built, and the No. 9 mixer situated east of the trestle was removed to make way for the stream-control culvert. The trestle which crossed the dam at its westerly end was demolished and the plant at that point reconstructed.

Concrete for all work on the dam and the terrace wall, the flume, and the blow-off, was mixed in three Hains-Weaver gravity mixers.

The mixers were supplied with cement by two continuous belt conveyors and a chute located in such a way that cement could be handled directly from the cement cars to the conveyors. Sand and stone were supplied by continuous belt conveyors to small bins above the mixers. The conveyor belts extending to the mixers were supplied, in each case, by a conveyor belt which ran under the large storage bins. The feeding conveyor at the southwest mixer was parallel to the conveyor which lifted the sand and stone to the top of the mixer, and an intervening hopper was required to collect the aggregate and feed it again to the elevating belts.

Concrete supplied by the mixers was conveyed in 2-yard Steubner bottom-dumping buckets on flat cars which ran on standard-gage tracks to the derricks, so arranged that a continuous loop circuit was possible, permitting the use of two cars simultaneously. A car on receiving an empty bucket and giving a full bucket immediately traveled to another derrick, supplying another full bucket at the new location and receiving another empty one; a second shuttle car received the first emptied bucket and supplied the first derrick with its next full bucket; the first car immediately after receiving the second empty bucket returned to the mixer for its next load of two full buckets, on its next round receiving the emptied bucket supplied by the preceding car. For a great part of the work at each end of the dam the shuttle cars were not used, the guy derricks swinging the buckets directly under a concrete supply chute provided especially for them.

The plant placing the masonry in the dam consisted of a number of travelers and of a group of guy derricks. The travelers were confined to the central portion of the dam, and guy derricks were used at the ends and top of the dam. The travelers were used as in 1913, but when working near the top of the dam it was necessary to increase the reach of the down-stream derricks by lengthening the booms to 67 feet. All of the concrete placed in Sections 1, 2, 3, 17 and 18 and part of the concrete placed in Sections 4, 5, 6 and 16 were handled by the guy derricks having booms about 90 feet long and masts 85 feet high equipped with 75-horse-power electric hoists.

At the Kensico dam at the beginning of the year a stretch of 300 feet at the westerly end had been completely excavated; concrete had been placed in 10 of the sections to an average elevation of 214.5, or the top of the second lift; very little of the rock excavation at the east end of the dam to the east of Section 15 had been done, and the cut-off trench had been excavated from the easterly side of Section 1, a distance of 1,165 feet, to about the easterly end of Section 16, and 1,050 feet of this length had been filled with mass concrete. At the end of the year the cyclopean and concrete-block masonry had been completely built up to Elevation 370 for a length of 1,388 feet between Expansion Joints 1 and 19.

Excavation for the dam was actively carried on throughout the winter until concreting was resumed in the spring. This work consisted principally of the preparation of the foundation of the dam at the east end, and in March about 200 linear feet were ready for masonry except for barring and wedging. Excavation at this point was also in progress intermittently until December, when drilling and excavation of the cut-off were actively resumed and general excavation was begun. At the west end of the dam barring and wedging were in progress throughout the year, extending to a point about eight feet west of Expansion Joint 1.

All rock excavation was done by air or electric drills or by barring and wedging, and the excavated material was loaded into skips by hand, the skips being raised by guy derricks to trains, which hauled the spoil to depressions between the site of the dam and the North Castle road. About 35,000 cubic yards of excavated material were removed from the site of the dam during the year.

Selected refill was placed at the up-stream face of the dam with material excavated by a steam shovel from the old lake bed. This

PLATE 14

KENSICO DAM—Valve well of Upper gate-chamber in center of up-stream face to control flows to blow-off and to Bronx conduit. Gate-house of old dam in background. Contract 9

material, which was a very fine sand, was dumped from trains into a pond in which the water was several feet deep. This refill was carried up to about Elevation 217. After this work was completed general refilling was begun, the shovel being moved to the down-stream side of the dam. Material excavated from the old Kensico dam was used to bring the fill on this side to Elevation 219 along the greater part of the length of the masonry built during the year.

Approximately 180,000 cubic yards of material were placed as refill against the dam on the up-stream and down-stream sides.

After refill had been placed against the dam the steam shovel excavated from the old Kensico dam and material so obtained was used to fill in depressions between the North Castle road and the dam. When the excavation for the dam was begun, the location of the proposed blow-off was followed as a means of entrance for excavation trains. A considerable portion of this region was too low for the foundation of the blow-off, and refilling was begun early in the year so that consolidation might be effected before the blow-off conduit was built. This area was afterwards flooded, and still later a small amount of material was placed and consolidated by a grooved roller. This area is also crossed by the Bronx Conduit extension, and its foundation area therefore received a corresponding treatment.

After the completion of the blow-off and the Bronx Conduit extension refilling over and around them was carried on and preparation for the foundation of the pool was begun, selected refilling material for this area being spread in layers kept wet by continuous sprinkling, and compacted by grooved rollers.

The portion of the flume lying within the limits of the pool was rebuilt as a concrete conduit with reinforced cover slab. Refill over this conduit was made by damming up the water in the conduit and forming a pool into which selected material was dumped.

Bulk filling only was placed on the area south of the pool and terrace. A steam shovel was brought down from the quarry to expedite the grading work, and after the portion of the old Kensico dam west of the waste conduit and above the general grade was entirely excavated, was moved to the foot of the West hill, bringing the grading to approximately final lines. Material from this excavation was placed immediately to the south of the terrace wall.

Placing concrete for the greater part of the length of the dam was carried on in a series of lifts of a definite hight. The masonry

at the ends of the dam, placed almost entirely by guy derricks, was brought up to any elevation which might be convenient for the derrick plant as arranged, conforming generally to the lifts built by the travelers. As much concrete as was possible was placed by the travelers, guy derricks being used on the more inaccessible sections. At times the guy derricks were supported on piers which were incorporated in the masonry as it rose around them, these piers being 10 feet square and built as a part of the tongue or groove of the adjoining expansion joint.

In the third lift, the elevation of the top of which was 239.5, the two traveler tracks were so close that there was not room enough for a service track between them. Two service tracks were therefore provided on the back-fill on the up-stream face of the dam, and three service tracks on the back-fill on the down-stream side of the dam. The travelers were always arranged so as to face each other, eight derricks being available on a section. In this lift the travelers were supported on large piers requiring no diagonal bracing or long timber struts.

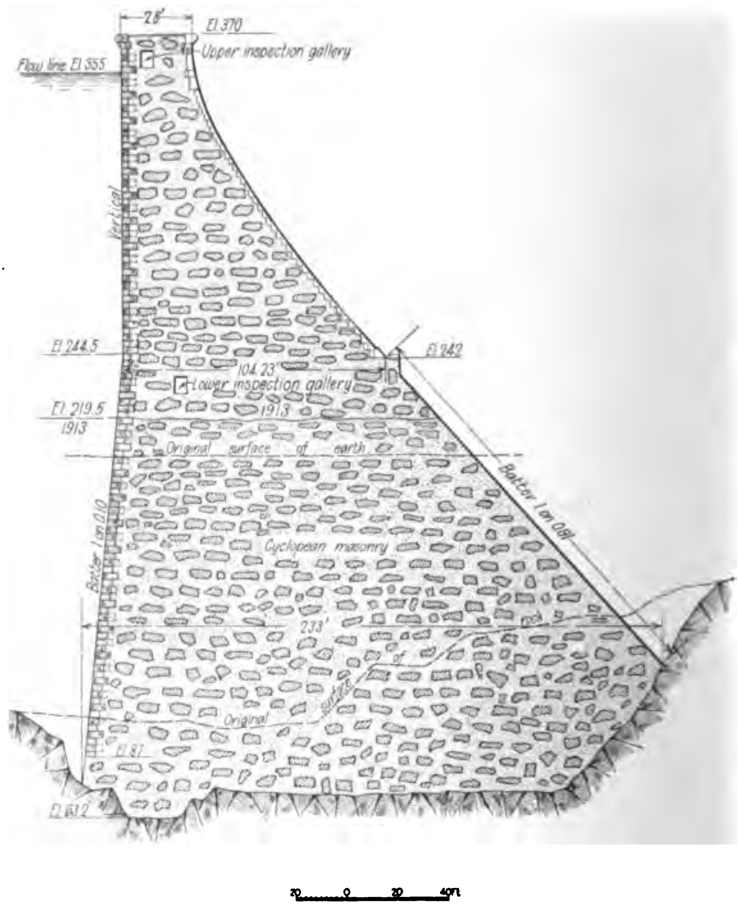
In the fourth lift, the upper surface of which was at Elevation 264.5, the cross-section of the dam was so narrow that two travelers could no longer be used abreast and only two travelers with four derricks were available at a section. In this and the succeeding upper lifts, the cyclopean stone and blocks were handled by the derricks on the up-stream side of the travelers, supplied from the service track on the up-stream side of the dam. In this lift concrete piers were not used, and piers built of blocks forming parts of the expansion joints were substituted.

In the fifth, sixth and seventh lifts, with top elevations of 289.5, 314.5 and 339.5 respectively, the arrangements of travelers and piers were in every way similar to those adopted for the fourth lift.

In the eighth and topmost lift, which had a rise of 29.5 feet instead of the usual 25 feet and the top of which was at Elevation 369, it was not possible for the travelers to be placed above their work as was usual, and they were kept at Elevation 339.5, placing concrete to the limit of the extent of their booms, after which concrete was placed by one traveler with the assistance of a guy derrick placed on top of the last completed section, the traveler being backed off and the guy derrick moved forward as the sections were completed. Two such combinations were in use at the beginning of the work on the eighth lift, but as the completed length increased one traveler and derrick were removed.

KENSICO DAM—Cut-off trench in foreground at right; drainage gallery above it; porous concrete blocks containing drainage wells over drainage gallery. Contract 9

SHEET 8



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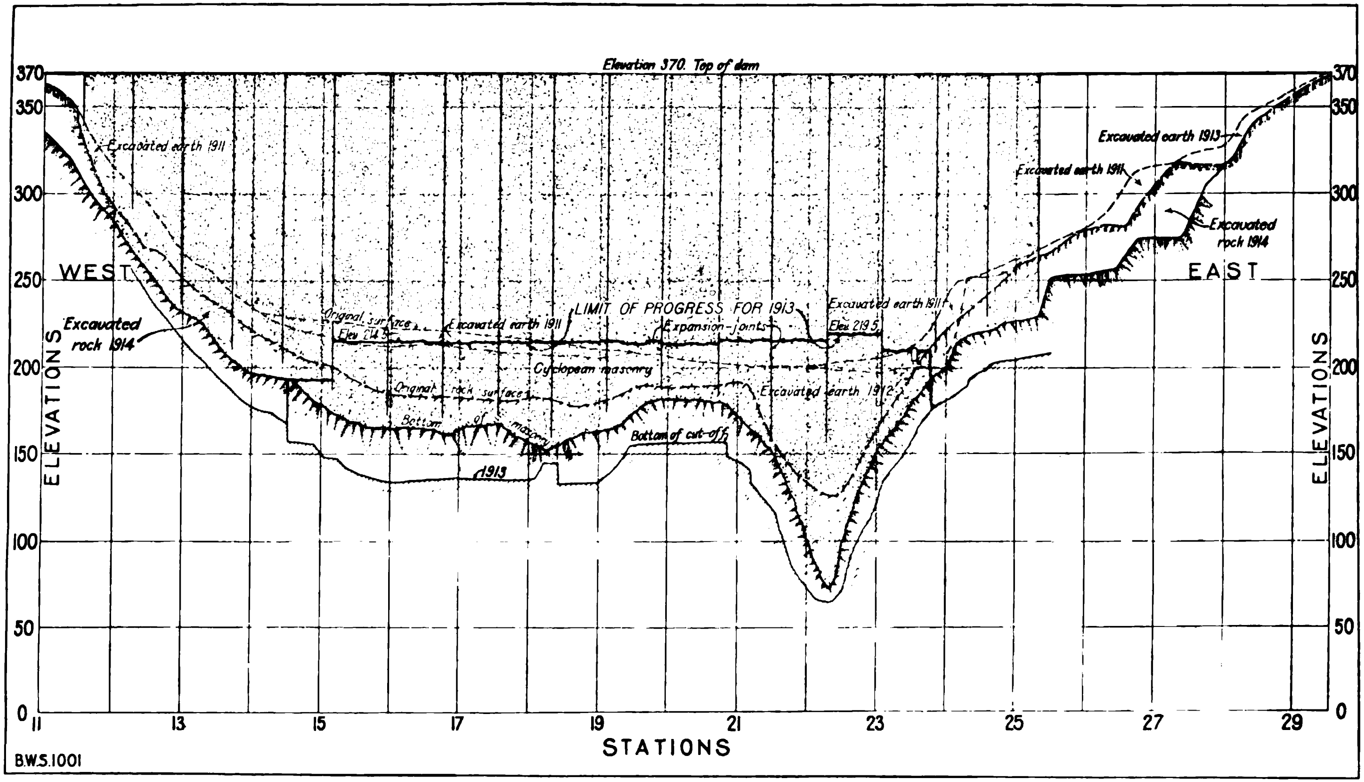
KENSICO DAM—Maximum cross-section, indicating masonry laid to December 31, 1914, for a length of 1,388 feet



KENSICO DAM—Longitudinal section showing progress in laying masonry to December 31, 1914. For a length of 1,388 feet the hight of the dam was raised over 150 feet

niches for the carrying of the reinforced-concrete beams of the roof, but none of the gates or gate-stem supports had been placed at the end of the year.

The reinforced-concrete blow-off connecting the Lower gate-chamber with the waste conduit was built, concrete being mixed in the two southerly mixers.

The Bronx Conduit extension, a 48-inch cast-iron pipe, connecting the Lower gate-chamber with the upper end of the old Bronx conduit at the core-wall of the old Kensico dam, was placed and successfully tested.

Copper strips in expansion joints were placed and the up-stream portion of the strips was grouted into a groove cast in the blocks. A grout of one part cement to two parts sand was used, and after the grout had completely hardened and had been pointed the outstanding edge of the strip was enclosed in the section of concrete placed in the space provided on the up-stream side of the inspection well. Concrete placed for this purpose was handled by a traveling crane on top of the dam, instead of by the cableway as was done previously, and a special bucket, small enough to enter the well and holding just enough concrete to pour a section 15 inches in hight, which was the vertical spacing of reinforcing bars, was used. Special forms were also developed for this purpose, which permitted the working of this concrete by hand as it was being placed.

Excavation at the east end of the dam in gneiss was further developed, and the dam extended about 200 linear feet eastward, where the rock surface was found to be seamy. The strata were drilled with holes perpendicular to the dip and fairly close together, these holes being extended upward through the masonry by 2-inch wrought-iron pipes and later grouted when the supporting concrete cover was sufficient.

Work on the relocated highways consisted of grading West Lake drive from Kensico dam to Kensico dike and the greater portion of the West Hill drive, laying a railroad track for handling excavation and borrow on the East Hill drive, and constructing four culverts on the West Lake and West Hill drives and one culvert on the East Hill drive.

No extension of the waste conduit was made, but the Y-section connecting with the blow-off was completed. In December excavation was begun where the East Hill drive crosses the line of the conduit and the excavated material was placed as fill for the drive.

Swamp stripping was resumed on a small area north of Rye

KENSICO DAM—Typical expansion joint. Note upper and lower inspection galleries and down-stream face stepped to receive granite facing. Contract 9

pond and east of Dark hollow, and filling of the portion of this area, which will be covered by less than five feet of water, was in progress.

Grubbing between Elevations 320 and 355, the latter the flow line of the reservoir, was in progress, 158 acres out of about 400 acres being completed.

The construction of stone walls was completed with the exception of several short stretches. During the year 1,990 linear feet of wall were built. The contractor's average daily force was 1,160 men and the maximum was 1,565 men.

MAINTENANCE BUILDINGS AT KENSICO DAM

Contract 135—*J. E. Butterworth, Contractor*

This contract is for the construction of the maintenance buildings at Kensico dam, consisting of a keeper's house and office, stable, garage, workshop, oil house and ice-house. The installation of electric fixtures, the only work remaining to be done at the end of 1913, was completed February 24, the final estimate being $23,153.24.

REMOVING CHESTNUT GROWTH AROUND KENSICO RESERVOIR

Contract 142—*Charles Cochar, Contractor*

This contract, for the removal of chestnut growth around the site of Kensico reservoir, was 60 per cent. completed at the beginning of the year and about 16 per cent. was done during the year, as measured by the partial estimates for payment. The camp in use during 1913 was discontinued. The work was carried on as before.

TREE TRANSPLANTS

Contract 156—*The North Eastern Forestry Company and Franklin Forestry Company, Contractors*

This contract, for furnishing, delivering and planting tree transplants at the Ashokan and Kensico reservoirs, was awarded April 7. This department supervised the work at the latter reservoir. Work was begun April 14, on which date the first shipment of trees was delivered. A tent camp was erected at the north end of the old Lake Kensico, the usual sanitary precautions being observed. Planting was begun on April 17 and completed on April 29, a total of 208,000 trees having been placed in permanent stands on areas aggregating about 154 acres. No planting was done in the fall season.

All trees were inspected by a representative of the State Department of Agriculture before planting.

White Plains Division

PLATT AVENUE SIPHON AND CUT-AND-COVER

Contract 53—The Elmore & Hamilton Contracting Company, Contractor; Augustus N. Hand and Stephen L. Selden, Receivers

This contract, which consisted of 4.6 miles of cut-and-cover aqueduct and the reinforced-concrete Platt Avenue siphon, was practically completed last year. The work was completed August 25, the final estimate amounting to $1,513,319.57.

All plant was removed from the line of the work during the early part of the year.

Camp Elmore was occupied until the completion of the contract, before which time most of the buildings had been removed. The area occupied by the camp was restored approximately to original grade. The treatment of the effluent from the camp filters was continued during the occupancy of the camp.

The principal work done during the year was the grading and grassing of about 3,040 feet of the aqueduct embankment, sealing of two construction manholes, one at the north end of Fort Hill siphon and the other 450 feet north of the southerly end of the contract, repairing about 3,000 feet of invert of aqueduct, building guard-rails and a 28-foot extension to the culvert at Platt avenue, and the placing of a small amount of paving. The hydrostatic test of the Platt Avenue siphon was completed January 6.

Hill View Division

PART OF YONKERS PRESSURE TUNNEL

Contract 54—George W. Jackson, Incorporated, Contractor; W. W. Crawford, Receiver

A little over 2.1 miles of pressure tunnel are included in this contract. At the end of the year 94 per cent. of the contract, as measured by the partial estimates for payment, was completed.

The work remaining to be done at the beginning of the year consisted of placing the arch at the top of Shaft 1, the general grading around each shaft, completing the details of construction in the Bryn Mawr Connection chamber, the hydrostatic test, and cleaning up. The work uncompleted at the end of the year included the replacing of the cracked manhole casting on the line of the west branch tunnel in the Connection chamber.

The only plant in use other than hand-tools and wagons used for cleaning up and for placing concrete arch at the top of the shafts, was a 40-horse-power Hudson gasoline engine and a 6-inch Worthington 2-stage turbine pump used to fill the tunnel for the hydrostatic test. The pump proved unsatisfactory when the head reached 180 feet, and its use was discontinued.

The concrete arch at the top of Shaft 1 was completed in June, some of the surplus tunnel spoil being disposed of in the shaft, the

YONKERS PRESSURE TUNNEL—Bryn Mawr Connection chamber, north facade. Contract 54

entire space below the arch being filled. During June the grading around the three shafts was completed and the areas cleaned up.

At the Bryn Mawr Connection chamber the large steel entrance doors were set up.

Pumping water for the hydrostatic test was begun in November, 1913. On January 8, during the filling of the tunnel, the west manhole casting in the Connection chamber cracked, and, although the casting did not fail completely, the test was temporarily suspended. The crack extended from the flange of the main pipe horizontally along the top of the pipe and up the side of the dome or manhole

to the cover flange, a total length of about three feet with a maximum opening of about 1/8 inch. The crack was fairly straight and normal to the interior surface of the shell, which is 2¼ inches thick. Leakage through this crack was about 138 gallons per minute, which began to diminish somewhat after a couple of weeks, at the end of a month had lessened to under four gallons per minute, and in two months had entirely ceased. Examination showed that the crack was completely filled with a hard white substance which on analysis proved to be chiefly carbonate of lime. During this time the head varied considerably, twice reaching approximately that obtaining at the time of the fracture.

The test was resumed, the casting being banded with 1-inch iron rods, three around the manhole dome and five around the main pipe, a strip of sheet lead about ½ inch thick and two inches wide being placed over the crack under the bands as a precautionary measure. Water was obtained from the Yonkers City main. The test was completed March 20, and on April 5 the tunnel was unwatered.

HILL VIEW RESERVOIR AND PORTIONS OF YONKERS AND VAN CORTLANDT PRESSURE TUNNELS

Contract 30—Keystone State Construction Company, Contractor

This contract includes the construction of Hill View reservoir, 1,200 feet of the Yonkers pressure tunnel at one end and the Van Cortlandt pressure tunnel, 1,800 feet long, at the other end.

At the beginning of the year there were completed about 93 per cent. of the reservoir excavation and construction of embankments, about 43 per cent. of the 6-inch concrete reservoir lining, about 58 per cent. of the 8-inch slope lining, and all but 280 feet of the By-pass aqueduct. At the end of the year there were completed about 99 per cent. of the excavation and construction of embankments, 88 per cent. of the 6-inch lining, 79 per cent. of the 8-inch slope lining, and all of the By-pass aqueduct and Dividing wall, and the contract work as a whole was about 91 per cent. completed. The pressure tunnels had been previously completed.

The camp buildings and sanitary measures were continued without change, the maximum population of the camp being 360.

The stone crushing plant at the Downtake shaft, comprising a 100-horse-power Erie engine, a No. 6 McCully gyratory crusher, screens, and conveyors for sand and stone, was dismantled in December. The No. 6 McCully gyratory crusher formerly used in connection with sand rolling was equipped with a rotary screen and

operated electrically by a Northern motor for crushing concrete aggregate, the crushed stone being conveyed to a pile near the gravity mixer at the Downtake chamber by a 90-foot belt conveyor. Two crushing and screening plants for the production of macadam surfacing material were installed. These plants each comprised a No. 5 Champion jaw crusher, a 30-horse-power Farquhar boiler and engine, and a 13-foot rotary screen.

The Abenaque portable 14-horse-power gasoline engine and the Sullivan air-compressor for the pneumatic drills were shipped away during the season, and the plant in use on excavation was gradually reduced during the year. At the end of the season the excavation and embankment plant consisted of one Baldwin and two Porter locomotives, twenty-five 4-yard Western dump-cars, 10,000 feet of 3-foot-gage track, one Western track spreader, one Champion road-scraper, one 10-ton Buffalo-Pitts steam roller, one 450-gallon Studebaker sprinkler wagon, two Worthington duplex pumps, and one 30-ton and one 60-ton steam shovel. Two American road-scrapers and seven wheel scrapers were used for trimming the reservoir bottom preparatory to placing 6-inch concrete lining.

The concreting plant in use at the end of the season consisted of one 15-ton traveling Brownhoist crane, 5,000 feet of track, three Edson diaphragm pumps, two electrically-operated derricks, four 1/3-yard Koppel cars, four motor-cars having 30-ampere 550-volt Westinghouse motors, 2,000 feet of 20-pound electric transmission rail, twelve 4-foot by 5-foot flat cars, six 1¼-yard Steubner controllable-bottom dump buckets, a 1½-yard Chicago mixer with engine and boiler, one orange-peel and one clam shell bucket and one Hains-Weaver 1¼-yard mixing plant with overhead stone bin, sand bins, and water-tank. The Hains-Weaver mixing plant was located near the Downtake chamber, stone and sand being supplied to the mixer bin each by a bucket conveyor and cement by a bag conveyor, all three conveyors being electrically operated. A similar plant located near the Uptake chamber was discontinued and dismantled early in October. Power for all motors was obtained from the power-house containing one 100-horse-power and one 125-horse-power Erie City return tubular boilers, a 100-horse-power Marion boiler, a 300-horse-power Atlas engine, a Stillwell hot-water heater and a 230-kilowatt 550-volt Ft. Wayne dynamo.

Other equipment used on grading and excavation work included one 6-ton and two 5-ton auto trucks, 40 Troy wagons and 78 horses.

The excavation in the reservoir basins was very nearly completed during the year, about 30,000 cubic yards of trimming and shallow

cutting remaining to be done in the East basin. A great part of the excavation consisted of shallow cutting and cleaning up immediately preceding the placing of concrete lining. All slope trimming was done by hand, the earth being shoveled to the foot of the slope and from there removed by steam shovels. Surface-water impounded during storms was discharged without pumping through the completed Wakefield Avenue blow-off into the Bronx river.

Embankment was built from the material excavated from the East basin. In the West basin the small amount of material to be removed was hauled up the paved inner slope in wagons by an electric hoist located on the top of the bank. At the end of the year the work remaining to be constructed consisted of approximately 20,000 cubic yards of 4-inch-layer embankment and 10,000 cubic yards of 2-foot-layer embankment.

About 600 linear feet of single 3½-inch vitrified clay duct were laid between the gate-chambers and adjacent property lines for future electric installation, and three concrete splicing chambers were constructed on these lines. The single-pipe ducts were laid in double lines on an invert four inches thick, the top of which had been carefully finished to grade, and then surrounded by a concrete envelope having a minimum thickness of three inches.

All silt and accumulated debris were removed from the Van Cortlandt pressure tunnel through the Downtake shaft by means of a bucket and an A-frame derrick erected over the shaft. A hydrostatic test of the Yonkers pressure tunnel was made in March in connection with the test under Contract 54. During this test the water was raised to the full-reservoir level in the chamber.

On June 9 the last section of the waterway portion of the Dividing wall was cast, thereby completing the waterway from the Ashokan reservoir to the New York City line, and the wall was completed on August 8. About 280 linear feet of the wall adjacent to the Uptake chamber were built.

The Blow-off conduit was completed, and connection was made with the 36-inch blow-off pipe in the invert of the Downtake chamber.

The 6-inch lining of the West basin was completed in November. The construction methods in use last year were followed except that during the latter part of the season the 2½-inch by 12-inch screed plank was replaced by a 4-inch by 6-inch timber resting on its 4-inch face, which produced a smoother finish. This improvement was due to the greater lateral stiffness of the timber, the lateral vibration of the 2½-inch plank causing ridges on the finished surface. The new

screed was not stiffened, but its lower face was cambered so that the weight of the timber would bring the lower surface to a straight line during the process of screeding. The bearing surface of the screed timber was shod with steel plates.

The berm wall was completed and 1,612 linear feet of toe wall were placed, 980 feet remaining to be completed. On the leveled reservoir bottom 1,333,430 square feet of 6-inch concrete lining were placed, leaving about 359,000 square feet remaining to be done. About 84,470 square feet of 8-inch concrete lining were placed on the berm and on the slope between the berm and the toe wall, leaving 88,030 square feet to be placed.

The dry-rubble paving was completed in November, and about 10,580 cubic yards of riprap were placed during the year, making a total to date of 20,780 cubic yards. All of the stone so far used for rubble paving and riprap has been obtained from the excavation, the boulders found on the site furnishing excellent material for this purpose.

Final grading consisted of a general smoothing up of the embankments involving filling in the depressions caused by storm water running down the slopes. The junction of the embankment slopes with the approximately level top of the embankment and with other fixed features of the landscape, necessitated particularly careful work to obtain the desired results while providing proper drainage.

The top-soil was placed on the smooth surface of the embankment as soon as it was acceptably graded, spread to a depth of six inches, and all raked out stones removed. Bradley's seeding down fertilizer was applied by hand and the treated area immediately sown with a mixture of rye, clover and grass seed. The grass seed was raked in immediately after sowing, and the ground was then lightly rolled. The seeded areas were kept wet by sprinkling.

Top-soil for the surface dressing was re-excavated from piles where it had been stored after stripping from the original surface, the greater part spread this year being loosened by black-powder blasts set off in holes drilled by a churn drill. The soil was excavated by hand after loosening and loaded into 1¼-yard Koppel cars, which were hauled to the top of the bank. The greater part of the top-soil was conveyed down the slope by a specially constructed grader with scraper blade about six feet long, hauled by two horses. After the soil was spread approximately six inches thick by shovels or drag scrapers the spreading was completed by hand rakes.

On final grading and placing of top-soil 508,500 square feet of embankment surface were graded and top-soil placed to a depth of six inches. Of this area only 140,400 square feet were seeded in time for the grass to obtain a fair growth. About 20 per cent. of the embankment surface was covered with top-soil during the year.

Grading of the roads and paths to be constructed under this contract was begun. This work was done by plows and scrapers and by hand, no side slopes steeper than 1 on 2 being constructed, all embankment being built up in layers consolidated by a steam roller before the telford or macadam was placed. About 2,800 linear feet of road and 5,500 linear feet of paths were graded.

During the year 900 linear feet of telford base nine inches in thickness were constructed, this base being thoroughly spalled and spread with 1¼-inch stone before rolling. After rolling was commenced 1¼-inch stone was added until the upper surface was brought to about one inch above the top of the stones in the telford base. A 4-inch course of 2½-inch stone was next placed, followed by two inches of 1¼-inch stone and the screenings. Material for the telford base was obtained from boulders transported to the site of the work and split up by the masons as needed. On the portions of the roads where telford base was omitted, a 4½-inch lower course of 2½-inch stone was placed, followed by 2½ inches of 1¼-inch stone and the screenings.

The two crushing and screening plants producing macadam and stone screenings were situated outside of the embankment lines; one on the west side of the reservoir and one on the east side. All material for telford and macadam was transported in 1½-yard Troy dump-wagons, a considerable quantity being placed and rolled, but none of the roads or paths were finished. A 10-ton Kelly-Springfield steam roller and a 10-ton Buffalo-Pitts embankment roller, with cleats removed, were used in rolling embankments, telford and macadam.

About 1,350 linear feet of paved gutter were constructed along portions of the access roads on the upper side of the reservoir to provide drainage of reservoir slopes. These gutters being four feet wide and eight inches deep at the center, 8-inch paving was used. The subgrade was first excavated and shaped by hand with the aid of a templet applied to grade and line stakes set 25 feet apart along the edge of the gutter. A sand-bed was then spread and the paving stone carefully set, after which the stone was thoroughly rammed with a heavy wooden rammer, the upper surface was spalled, and sand was swept in.

Ten concrete catch-basins with cast-iron tops, and five concrete manholes with reinforced-concrete removable covers, were constructed.

From the gate-chambers to the outer slopes of the adjacent embankments 350 linear feet of 6-inch vitrified pipe were laid to drain the floors of the chambers; and the various catch-basins and manholes were connected and drainage to adjacent watercourses and to the Wakefield Avenue blow-off provided by the construction of storm sewers in which 600 linear feet of 12-inch pipe, 530 linear feet of 15-inch pipe and 1,520 linear feet of 18-inch pipe were used. All back-filling placed in the drainage-system pipe trenches was placed in layers and carefully rammed.

The drainage conduit at the southwest corner of the reservoir, a concrete culvert having a 2-foot by 3-foot waterway, was extended northward alongside of Central Park avenue a distance of 140 feet to connect with a catch-basin on the north side of the access road to the Downtake chamber. This conduit receives water discharged through an old culvert across the avenue, and an opening in the conduit, temporarily closed with brickwork, was therefore provided for the benefit of the City of Yonkers when the old culvert is rebuilt.

At the northwest corner of the reservoir, where filling to a depth of from 5 to 20 feet was placed for the approach to the Uptake chamber, drains laid by the original owners of the property to care for the water discharged from an extensive system of underdrains on the Empire City Race Track property and from the lands west of Central Park avenue, were in part taken up, cleared of silt and relaid in their original location before the embankment was built.

Hydrostatic tests of the By-pass were made December 21 and 22 under heads respectively 15 feet and 7 feet less than the full-reservoir head, and after the completion of these tests water was allowed to flow into the West basin to a depth of six feet partly as a protection for the concrete lining during the winter and partly to prove the tightness of various gates and structures.

The contractor's average daily force was 315 men and the maximum was 508 men.

Elmsford and Bryn Mawr Blow-Offs

Contract 79—Thomas O'Hern, Contractor

This contract is for the construction of Elmsford and Bryn Mawr blow-offs in the White Plains and Hill View divisions respectively. The construction of the Elmsford blow-off was assigned to the Grannis and Warley Contracting Co., March 23, 1914, by the

James Duell Construction Co., the original assignee of this work. The unassigned portion was completed and the remainder practically completed during the year.

On the Elmsford blow-off all of the plant in use in 1913 was continued in use. The 200-foot cableway was in use about one month, after which it was dismantled and all subsequent excavation was done by hand. In the construction of the arch 60 feet of Blaw steel forms were used, and for the invert wooden forms were in use. Concrete was mixed in a ½-yard cube mixer, the stone being ob-

YONKERS PRESSURE TUNNEL.—Bryn Mawr Blow-off channel in bed of Sprain brook. View from Bryn Mawr siphon. Contract 79

tained from a quarry west of Elmsford and sand from a sand-pit about one mile east of Elmsford.

The Bryn Mawr blow-off comprises about 5,400 feet of concrete-lined open channel, and concrete Headworks consisting of a sub-surface chamber. This portion of the contract was completed October 20, the value of the work amounting to $65,175.96.

The small amount of material remaining to be excavated for the channel was removed by pick and shovel and by wheelbarrows. At the Headworks the material was taken out by means of buckets and a steam-operated derrick. The principal plant in use, other than

hand-tools, was a pulsometer pump, two Emerson pumps, a 100-horse-power locomotive boiler, a 65-foot guy derrick with hoisting engine, boiler and swinging gear, a ¾-yard rotary drum concrete mixer, a 1½-horse-power gasoline-operated diaphragm pump, a 700-pound steam-hammer, four ½-yard buckets and three drag scrapers.

The material excavated at the Headworks was water-bearing sand, coarse at the top and changing to quicksand near the bottom. The excavation was sheeted with a single thickness of 3-inch tongued-and-grooved spruce with 10-inch by 12-inch rangers and braces. Two sets of 18-foot sheeting were required, and in the deepest part of the excavation a third and shorter set was driven extending several feet below the subgrade. The driving of sheeting was principally done with a steam-hammer. About 500 gallons of water per minute were pumped from the excavation during the progress of the work.

At the Central Avenue bridge the excavation required extreme care as the subgrade of the channel was seven feet below the footing courses of the bridge abutments. Timbers, 10 inches by 10 inches, were braced across the excavation between the bases of the abutments at distances of five feet between centers. The work was advanced five feet at a time, the excavation being made and concrete placed and allowed to set in one section before the next was started. Excavation of the small amount of ledge-rock was carried on by barring and wedging.

At the Central Avenue and Palmer Avenue bridges the stream was carried, during construction, in a flume 4½ feet wide and 2 feet deep, about 4 feet above the invert grade of the channel.

The excavation for the continuation of the channel up-stream from the Headworks was done after the brook had been diverted and the ground-water lowered by pumping at the Headworks.

For the Headworks excavation a double timber platform was required over the entire bottom owing to the wet foundation. This platform was built up of two layers of 1-inch boards separated by laths and laid on 2-inch by 6-inch stringers, all drainage being led into a 10-inch by 12-inch wooden box drain and through the drain into a wooden box sump which was located just outside of the neat lines of the structure. A layer of crushed stone averaging two inches in thickness was spread over the entire area before placing the platform.

A layer of concrete six inches in thickness was placed on the timber platform with gaps about three feet in width at the points

where the calking of the 48-inch pipes would occur. After this concrete had set, the lower set of cross braces was removed, the two lines of 48-inch pipe lowered into place, the joints calked with lead wool, and the remainder of the concrete placed around and over the pipes in one operation. At the uptake portion of the Headworks the 2½-foot foundation was first laid over the whole base and carried to the sheeting on all sides. The walls were carried up in lifts of about four feet according to the location of the braces, only one set of braces being removed at a time. Outside forms were used for the walls, and the space between the walls and the sheeting was back-filled as the concrete rose.

The concrete channel extending about 150 feet above the Headworks was placed without a timber platform, and expansion joints were made in the invert at intervals of 50 feet. The inclined sides of the channel were placed in 12-foot sections.

The concrete used at the two bridges was mixed by hand and that used at the Headworks was mixed in the rotary mixer, aggregate being obtained from the Tuckahoe marble quarries and a supply of natural sand from local sources and from the Headworks excavation.

The construction of the blow-off channel has resulted in lowering the ground-water level from three to five feet, practically drying up the swamp that originally existed along the entire length of the channel. All excavated material was used in filling the old brook bed and low portions of the adjoining land, the 1 on 2 side slopes of the concrete channel being continued upward above the concrete and uniformly trimmed and graded with rounded shoulders. Along the channel all of this excavation work was done with shovels and wheelbarrows, but at the Headworks wagons and scrapers were used.

Top-soil was placed on the slopes and shoulders of the channel and on a strip varying in width from 8 to 30 feet on both sides of the channel, the average depth of soil dressing on the slopes being eight inches. The area immediately surrounding the Headworks was also covered with top-soil and seeded. Army worms completely destroyed about 1,000 feet of the seeded area on the south bank and about one acre on the north side. These areas were reseeded.

Brooks, ditches and street gutters were admitted to the channel by suitable inlets with paved approaches. Drainage from the Bryn Mawr Connection chamber was provided for by a ditch two feet wide with side slopes of 1 on 1½, and a ditch with a bottom width of three feet and side slopes of 1 on 2 drained the low area at the foot of the tunnel spoil-bank.

The contractor's average daily force was 43 men and the maximum was 119 men.

Fences at Reservoirs and Along Catskill Aqueduct

Contract 101 (*District* 6)—*The Degnon Contracting Company, Contractor*

This district comprises about 22.7 miles of wire fence and about a mile of wooden fence and stone wall. The work was practically completed at the end of the year.

In the Croton division casting of posts was completed and the setting of posts as well as the fencing was practically completed as far south as Millwood. Fencing from this point to the south end of the division was also completed. The plant in use during the year was substantially the same as that in use in 1913.

In the Kensico division placing posts and erecting fencing were begun June 11 and were completed October 28, with the exception of the replacing of a few defective posts and a small amount of cleaning up. The fencing erected in this division is principally along highways.

Work in the White Plains and Hill View divisions was completed with the exception of minor details in the early part of December.

Portion of Catskill Aqueduct Telephone System

Contract 148—*Lord Electric Co., Contractor*

This contract, for the construction of the additional part of the Catskill Aqueduct telephone line extending from Croton lake to the New York City line, about 28 miles in length, was awarded June 23, and work was begun July 9.

The work consisted of stringing wires on the pole line erected under another contract and adding cross-arms, braces, insulators, pins, wires, cables and protective devices and moving and replacing some old poles. From the north end of Millwood tunnel to the south end of Sarles tunnel the line was carried through the aqueduct, the wires being supported by insulators on a steel angle bolted to the masonry about 12 inches below the crown of the arch and above the hydraulic grade line. One circuit composed of No. 8 bare copper wire was installed on the pole line and two circuits in the tunnel portion of the line. Cross-arms and pins were provided for a total installation of five circuits for the entire length of the line. All wiring was completed and a satisfactory speech-transmission test was made over all portions of the line on November 13.

Sluice-Gates, Stop Disks and Operating Mechanisms

Contract 41—Ogden Iron and Steel Manufacturing Company, Contractor

The portion of this contract included in this department covers the furnishing, delivering and installing of sixteen 5-foot by 15-foot sluice-gates with necessary operating mechanisms, except motors, for the Uptake and Downtake chambers of Hill View reservoir.

The installation of the five 5-foot by 15-foot sluice-gates and operating mechanisms at the Uptake chamber was completed in 1913, and the installation of the eleven 5-foot by 15-foot sluice-gates with operating mechanisms at the Downtake chamber was practically completed during this year. Numerous minor adjustments, repairs and replacements of broken and missing parts and the grouting in of the gates were in progress at the close of the year.

Sluice-Gates, Gate-Valves and Operating Mechanisms

Contract 43—Coffin Valve Company, Contractor

The work under this contract in this department consists of furnishing and delivering gate-valves and sluice-gates, and in addition installing certain other gate-valves for the aqueduct and Kensico and Hill View reservoirs. All of the gates and valves to be furnished were delivered in 1912.

The 48-inch and 36-inch gate-valves in the Lower gate-chamber at Kensico dam were installed in April, these gates being on the Blow-off conduit and the Blow-off Conduit by-pass respectively. The operating mechanisms for these gates remained to be installed. In the Hill View Reservoir Downtake chamber the operating mechanisms of the three 36-inch valves were installed and adjusted.

Sluice-Gates and Operating Mechanisms

Contract 44—Coldwell-Wilcox Co., Contractor

The portion of this contract in this department provides for the furnishing, delivering and installing of sluice-gates for the chambers at the steel-pipe siphons, the gate-chambers at Kensico reservoir, and the Downtake chamber of Hill View reservoir. The installation of the sluice-gates and operating mechanisms for the siphon chambers was practically completed in previous years.

At the Influent and Effluent chambers of the Kensico reservoir the sluice-gates were grouted in and the operating mechanisms were

adjusted. The installation of two 4-foot by 4-foot sluice-gates at Kensico dam remained to be done. The 4-foot by 5-foot sluice-gate in the Downtake chamber at Hill View reservoir was finally adjusted and some repairs were made during the season.

Gaging and Metering Apparatus

Contract 110—*Builders Iron Foundry, Contractor*

This contract, for furnishing, delivering and installing gaging, metering and other apparatus for various structures along the line of the Catskill aqueduct, was awarded January 6. The portion of the contract in this department was completed excepting the installation of the recording apparatus for the 36-inch Venturi meter at Kensico dam and the furnishing and delivering of the remainder of the 128 cable hangers to be used in the splicing chambers at Rye Outlet bridge.

UP-KEEP OF STRUCTURES

All up-keep work was done by the Board's force of laborers supervised by the field offices.

Hydrostatic Tests of Aqueduct

Further hydrostatic tests of the Croton Lake pressure tunnel were made, these tests showing a general decrease in the amount of outward seepage.

A hydrostatic test of the aqueduct between the South chamber of Hunters Brook siphon, and the South chamber of Turkey Mountain siphon was made by closing the gates at the respective chambers and allowing the aqueduct to fill by tunnel infiltration augmented by water diverted from the brook crossing the aqueduct south of Hunters Brook tunnel. Water was allowed to flow from the brook into the aqueduct until the top of the weir at the South chamber of Turkey Mountain siphon was reached, when the brook flow was stopped and the tunnel infiltration gaged by measuring the amount of water flowing over the weir.

A corresponding test between the South chamber of Turkey Mountain siphon and the Croton Lake Downtake chamber was made by lowering into place and tightly calking the stop shutters at the Downtake chamber, building a wooden bulkhead in the waterway leading to the Blow-off chamber and gaging the flow over the weir between the main waterway and the Blow-off chamber.

A hydrostatic test of the Yonkers pressure tunnel was also made.

Supplemental Construction

The Board's forces were engaged in raking out and grouting expansion joints in cut-and-cover aqueduct, placing marking tiles inside the aqueduct, casting and setting monuments for the center line and taking line, the construction of 10 reinforced-concrete pedestals to support the pump float at the Croton Lake Downtake shaft, and repairing the embankment and reseeding small areas along Bryn Mawr siphon. The 4-inch bronze pipe through the wall between the Downtake shaft and Blow-off chamber of Croton Lake pressure tunnel supplying water to operate the 60-inch valves cracked, and this defect was remedied by placing within it and grouting into place a 2-inch bronze pipe with an increaser in the Blow-off shaft to connect with the 4-inch piping furnished under Contract 42.

All blow-off gates were cleaned, lubricated, and tested, and hand-operated tests of the gates in several of the chambers and the Kensico Influent weir were made.

Boundary walls were repaired and rebuilt where necessary and dead trees were removed, and grass, weeds and brush were cut and burned along the line of the aqueduct. Ditches and drains were repaired and culverts cleaned out.

Forestry

The work of reforestation which was begun in 1911 was continued throughout the current year, the work comprising improvement clearing and permanent planting.

Improvement Clearing.—This work includes the removal of dead, diseased or malformed trees around the margin of the reservoir, with the exception of chestnut growth, which was covered by Contract 142; and also the complete clearing of a strip 40 feet in width intended to act as a fire-stop, inside the taking-line wall in all wooded portions.

Permanent Planting.—During the year 168 acres were planted in permanent stands, making a total of 597 acres in addition to the work under Contract 156.

A total of 8,038 specimen trees from five to six years old was moved from the nursery, a few being used to fill in a stand near the nursery and the greater part placed in permanent locations at Kensico dike and in the region south of the dike, these areas approximating 14 acres in extent.

Fires.—Several fires occurred during the year in the permanently planted areas. In addition to these, ten other minor fires

occurred on lands adjacent to planted areas, but no damage to the trees resulted. A fire patrol consisting of three or four men stationed at various points on the reservoir area was on duty Sundays and holidays.

Tree Nursery.—The tree nursery was maintained throughout the year, the work comprising the raising of trees from seed for planting in permanent stands and the transplanting and cultivation of trees purchased for ornamental planting. The winter covers were removed from the seed-beds on April 4, and the stand, consisting entirely of arbor vitae, was found to be in good condition. About 87,000 seedlings were obtained. On May 15 the seed-beds were replanted with arbor vitae seed, the stand obtained from which was very unsatisfactory.

During the year 14,300 square feet of new transplant beds were prepared, making a total of 22,780 square feet, in which were planted the 87,000 seedlings obtained from the 1913 planting.

Nursery Planting.—No new stock was planted during the year, and as the nursery supplied 8,038 trees for the permanent stands, the stock on hand was 184,160 trees of 11 varieties, somewhat less than at the end of 1913.

THERMOPHONES

Forty-seven thermophones have been placed in two groups in Kensico dam; one group of 20, designated by letters, having their sensitive coils in a vertical plane about three inches west of the back of the blocks forming Expansion Joint 12, and the other group of 27, designated by numerals, in a vertical plane midway between Expansion Joints 12 and 13, all of the coils being distributed at definite locations throughout these sections. Thermophones 2, 3 and 4 placed in the rock, and 5 to 11, inclusive, and A to E, inclusive, at Elevation 200, were placed during 1913, the remaining 32 having been placed during the current year.

All of the thermophones were in good working order except 4 and 8, both of which ceased recording shortly after being placed. Readings were not at first obtained from Thermophone D, but the cable was later found to have been jammed and upon relieving the pressure readings that appeared to be reasonable were obtained. The lead-armored cables connecting the sensitive thermophone coils with the recording mechanisms were incorporated in the masonry and run to the inspection wells at Expansion Joints 12 and

13, and thence up or down in the wells to niches formed in the sides of the inspection galleries. The cable from the thermophones placed near the top of the dam at Elevation 350 and above was run to a similar niche immediately east of Expansion Joint 12 on the south side of the upper inspection gallery. There will, therefore, be three boards for the recording mechanisms, two of which have already been installed. Readings of particular thermophones were taken at very short intervals during the day in which they were placed, and in one case such readings were continued throughout the night. Readings were subsequently made with less frequency, but care was taken to secure a sufficient number to establish the temperature curve. All thermophones were calibrated to determine their index errors before being placed in the dam, these errors being invariably found to be practically a constant. The indicating instrument in use in 1913, limited in range from 32 degrees to 100 degrees Fahrenheit, was exchanged for that used by the Reservoir department, which reads from 0 degrees to 180 degrees Fahrenheit. These instruments were very delicate and required frequent repairs.

To avoid the possibility of the pulling apart of the lead cables due to their dead weight they were hung in the inspection wells by clamps supporting the cable at intervals of 12½ feet, installed in the corners of the wells. Boards were fastened to these clamps to protect the cables from injury by falling objects.

CITY AQUEDUCT DEPARTMENT

WALTER E. SPEAR, *Department Engineer*

ORGANIZATION

The department organization consisted of four divisions as at the close of 1913. During the year, as tunnel lining and grouting approached completion, the force was gradually reduced in the two tunnel divisions. Part of this reduction was taken up by the Conduit and Reservoir division, whose work was increased by the starting of three new contracts. The net result at the end of the year was a decrease of 38 from December 31, 1913.

EMPLOYEES IN CITY AQUEDUCT DEPARTMENT—1914

	January 1	December 31	Maximum	Minimum
Engineers and clerks	170	137	178	137
Laborers	8	8	8	7

EXECUTIVE DIVISION

J. S. Langthorn, *Division Engineer,* 250 West 54th Street

This division assisted the Department Engineer with the general inspection and supervision of the field work of the department, had charge of the routine matters in connection with progress reports and the estimates of the field divisions, prepared special reports, investigated complaints, regulated deliveries, supervised field inspections and estimated the material in connection with Contracts 70, 84, 104, 105, 110 and 146 for valves and metalwork. During the year the division co-operated with Headquarters department in preparing plans and specifications for the main-line contracts, 86, 88 and 99, and valve contract 104. Assistant Engineer Martin J. Ungrich continued in charge of all engineering matters. The force of the division averaged 16, varying between 15 and 18. At the close of the year the force was 16.

BRONX DIVISION

William B. Hunter, *Division Engineer,* 700 West 181st Street

The Bronx division continued in charge of the two northerly contracts of the City tunnel, 63 and 65, which extend from the City line to Central park and 99th street.

Division Engineer James F. Sanborn continued in charge of the division work until November 30 when he was given charge of the Manhattan division. On December 1 William B. Hunter, Mr. Sanborn's assistant, was placed in charge of the division.

The number of employees at the end of the year was 47, and the average for the year 68.

MANHATTAN DIVISION

James F. Sanborn, *Division Engineer,* 250 West 54th Street

This division continued supervising construction work of the two southerly contracts of the City tunnel, 66 and 67, extending from Central park and 99th street to the two terminal shafts in Brooklyn at Third avenue and Schermerhorn street, and in Fort Greene park.

Lazarus White continued as division engineer until November 3, when he resigned and was succeeded by James F. Sanborn, previously in charge of the Bronx division.

On December 31 the division force was 42. The average force for the year was 54, the variation being between 42 and 76.

CONDUIT AND RESERVOIR DIVISION

John P. Hogan, *Division Engineer*, 100 Barrett Boulevard, Tompkinsville

The Conduit and Reservoir division is charged with the construction of pipe-lines in the Boroughs of Brooklyn, Queens and Richmond and Silver Lake reservoir on Staten Island. Early in the year the Bay Ridge conduit, Contract 75, was completed. During the year the construction of Silver Lake reservoir, Contract 89, was continued. Work was started on a portion of the Queens conduit, Contract 86; the Narrows siphon, Contract 99, and a portion of Richmond conduit, Contract 88. The maintenance periods under Contracts 87 and 103, completed during 1913, continued in force until March 11 and February 18, respectively.

The average force for the year numbered 29, the variation being between 13 and 43. At the close of the year the force was 38.

Offices

The offices of the department and the Manhattan division remained at 250 West 54th street; that of the Bronx division at 700 West 181st street; and that of the Conduit and Reservoir division at 100 Barrett boulevard, Tompkinsville, Staten Island. On May 19, possession was taken of the quarters at 179 Willoughby avenue, Brooklyn, provided by the Beaver Engineering and Contracting Co. under the terms of their contract, and on June 25 the Narrows siphon section office was provided at Arrietta street and Stuyvesant place, Tompkinsville, in a similar way by the Merritt & Chapman Derrick & Wrecking Co.

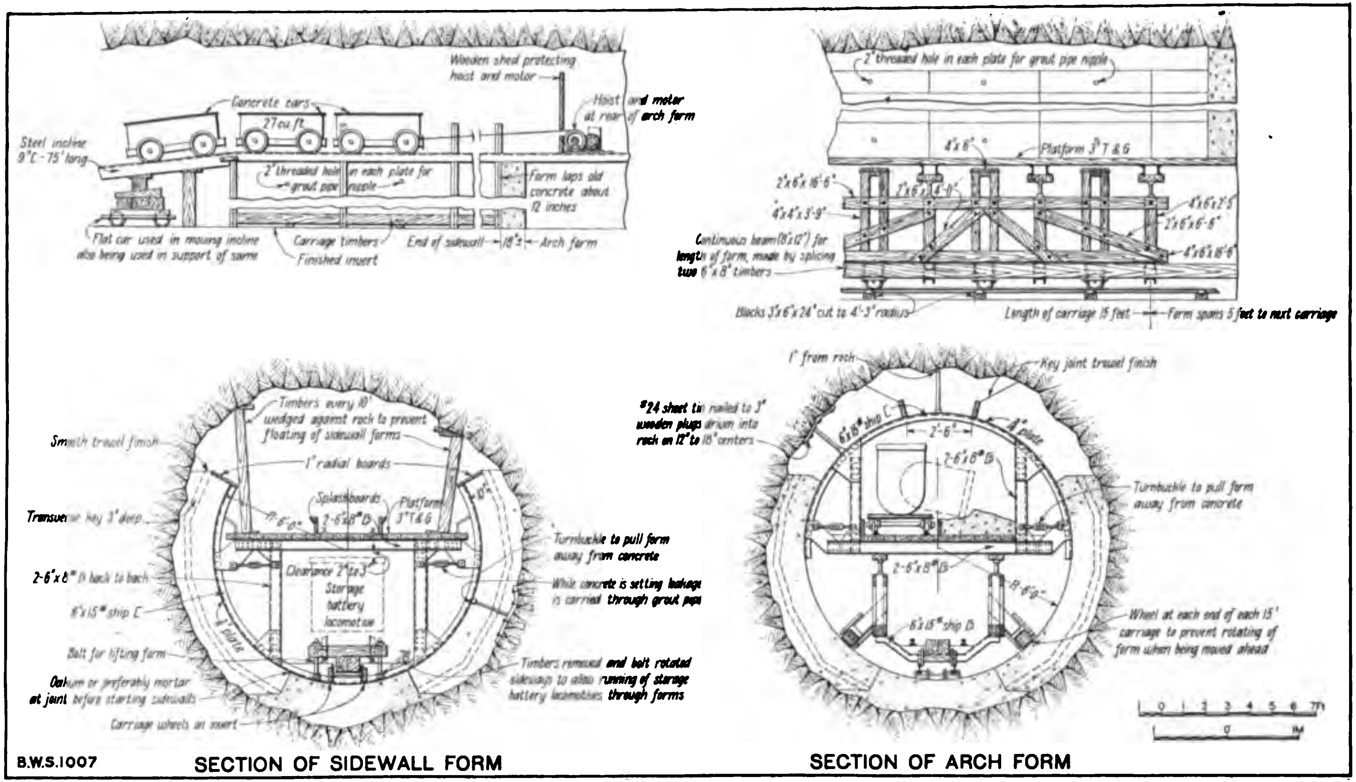
CONSTRUCTION

Bronx Division

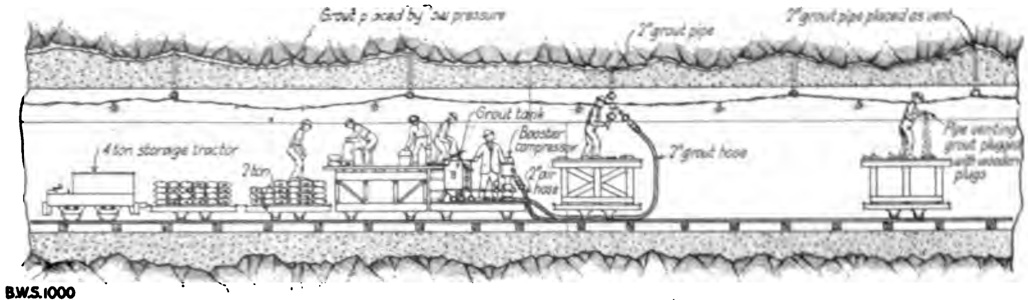
CITY TUNNEL—CITY LINE TO BURNSIDE AVENUE

Contract 63—Mason and Hanger Company, Contractor

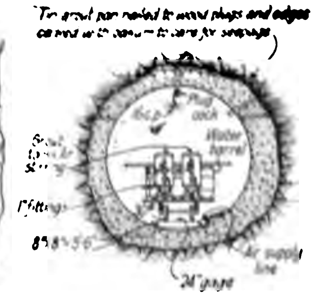
This contract, the northerly portion of the City tunnel, is for the construction of 21,267 feet of pressure tunnel 15 feet in diameter, and of five shafts varying in depth from 175 feet to 245 feet. Shaft 1 was sunk for construction purposes only. Shafts 2, 4 and 5 have a single 48-inch riser, and Shaft 3 has two 72-inch risers. During the year the remainder of the tunnel concrete lining—19,196 feet of side walls and arch, was placed; the entire tunnel



CITY TUNNEL—Side-wall and arch forms



GROUTING CONCRETE TUNNEL LINING



SECTION

2 0 2 4 6 8 10 Ft. 0 1 2 M

GENERAL DESCRIPTION

The operation of grouting the tunnel was divided into two distinct operations: Low pressure grouting and high pressure grouting. The object of the former was primarily to fill the space at the top of the arch left by the shrinking of the concrete away from the rock and to fill openings at joints and honeycombed places. The object of the latter was to fill open seams in the rock surrounding the tunnel and all pipes and pans placed to control water seeping into the tunnel.

Air pressure was used to force grout from the mixing tank through the hose and grout pipe into the voids to be filled.

LOW PRESSURE GROUTING

Each unit consisted of a grouting car equipped with two grout tanks, one cement car, two platforms on wheels, six flat cars, two electric storage tractors and three shifts of men. Air at a pressure of 100 pounds per square inch at the shaft compressor was used in the machines at a pressure of 95 pounds.

Only pipes located in the key portion of the arch were connected to in low pressure grouting.

The grout hose was connected to pipes situated at points where the rock roof was low; pipes at high points acted as vents. As grout flowed along top of arch, first water appeared through joints between successive days' work and from grout pipes embedded in arch; this water was followed by grout which became thicker and thicker and finally clogged all leaking joints; all pipes running grout were stopped with wooden plugs and the valves on key pipes were closed.

In low pressure work the hose was connected directly to valves on key pipes instead of on the Y-branches shown.

Grout was forced ahead 100 to 300 feet before the machine was moved to the end of the grouted portion.

The standard low pressure batch was 1 bag of cement, 95 pounds of sand and about 7 gallons of water. This batch made 2.04 cubic feet of liquid grout or 1.92 cubic feet of set grout.

HIGH PRESSURE GROUTING

Twenty-four hours after any section of tunnel had been grouted by low pressure, all pipes which were to be connected to were cleaned out to rock to allow effective treatment by high pressure grouting.

Each unit consisted of one grouting car equipped with one grout tank and one booster compressor, one cement car, two platforms on wheels, three flat cars and two electric storage tractors and generally one shift of men. Air was delivered from the shaft compressor to the booster compressor, which raised the 95-pound pressure to 300 pounds.

High pressure grouting was accomplished generally in one trip over the section of tunnel.

The grout hose was connected to the pipes by a Y-branch, as shown, to allow a rod to be forced in for the purpose of freeing a passage for the grout which often became jammed in the pipes by the high pressure.

All grout pipes that were connected to had grout forced into them at 300 pounds pressure, which was maintained for 5 minutes.

The standard high pressure batch was 1 bag of cement and 5¼ gallons of water, which made 1.24 cubic feet of liquid grout or 1.2 cubic feet of set grout.

CITY TUNNEL. Method and details of grouting concrete tunnel lining

was grouted, cleaned and calked; all shaft closures were made and the valve-chambers at the tops of Shafts 2, 3, 4 and 5 were built. The contract was 99 per cent. completed as measured by the monthly estimates for payment.

The tunnel concreting plants at Shafts 2 and 4 continued in operation until September 30 and October 7 respectively. These plants were described in the 1913 annual report. A total of 32,200 cubic yards of concrete was placed in side walls and arch from the Shaft 2 plant, the average rate being 5,360 cubic yards per month, and from the Shaft 4 plant 46,800 cubic yards, at an average rate of 7,200 cubic yards per month, were placed. The best week's work was from the Shaft 2 plant when 670 feet of side walls and arch were concreted, amounting to 2,380 cubic yards.

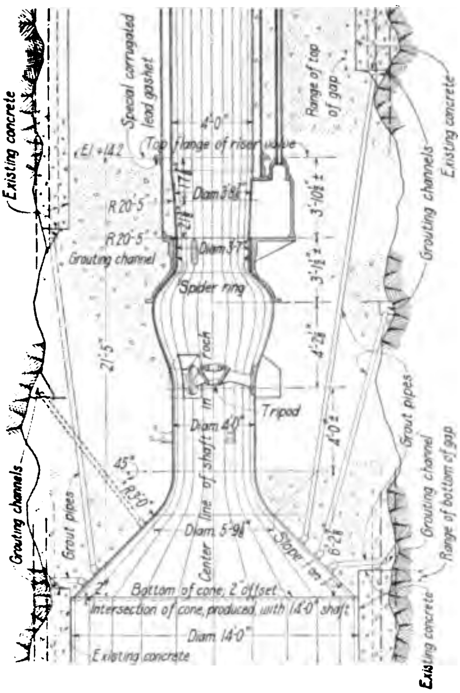
Grouting was carried on with three rigs, each consisting of the following: One 30-horse-power electric motor, one Ingersoll-Rand 2-stage belt-driven compressor capable of delivering 170 cubic feet of free air per minute at 100 pounds pressure and 130 cubic feet at 350 pounds pressure, one McGowen geared pump, capacity 50 gallons per minute, driven by a 7½-horse-power electric motor, two grout tanks of the air-stirring type, and two water-tanks placed above the grout tanks by means of which the exact amount of water required was automatically measured.

Grout pipes, two inches in diameter, for forcing in grout, were placed about 40 feet apart in the arch of the tunnel, one being at every transverse joint. Vent-pipes, also two inches in diameter for allowing air and water to escape during grouting, were usually placed about 50 feet apart into high cavities as the concreting progressed. Deep-seated pipes were wedged into holes drilled into water-bearing seams during excavation and pans of sheet iron with grout and vent-pipe connections were placed over water-bearing areas just before concreting to conduct the water away and prevent it washing out the fresh concrete. Where the wet area was in the lower part of the side wall, broken stone was substituted for the sheet iron, with bags of dry concrete placed over the stone.

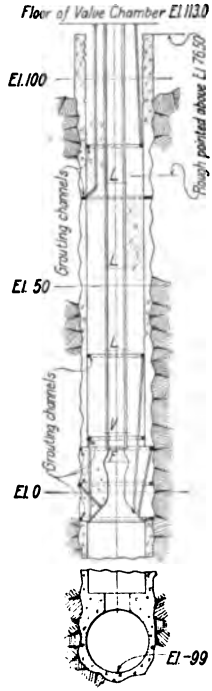
Low-pressure grouting commenced May 27. In the section to be grouted the pipe nearest the waterway surface was connected to the grouting machine by rubber piping, and batch after batch of grout was forced ahead under 100 pounds pressure as long as the connection would take grout. The mixture used was one bag of cement, 80 to 100 pounds of fine white beach sand and 8 to 10

gallons of water. As grout came out of the pipes ahead of the one connected to the machine they were closed by wooden plugs. Usually, low-pressure grout could be forced ahead about 100 feet. This operation was repeated by connecting to the first pipe ahead which had not showed grout. About 20 hours after grouting, vent-pipes and all selected pipes were opened to be used for connections in high-pressure grouting. Water-bearing pipes in the arch closed by the low-pressure grouting were opened up by an iron auger for high-pressure grouting.

High-pressure grouting was conducted with the same outfit used for low pressure but with the compressor adjusted to deliver air under 300 pounds per square inch. High-pressure batches were varied more or less to suit conditions, but in general vent-pipes making more than one gallon of water per minute and deep-seated pipes were given one bag of cement to 25 gallons of water. After refusal at 300 pounds per square inch, the valve was opened, the water allowed to drain out, and finally a mixture of one bag of cement and five gallons of water was forced in. On pipes making less than one gallon per minute, high-pressure operations were started by using one bag of cement and five gallons of water. High-pressure grouting was begun by finishing the grouting over the arch; next, all deep-seated and water-bearing pipes were grouted and finally the pipes leading from pans and blind drains over water-bearing areas. In high-pressure work every open pipe was grouted; however, after valves were removed it was found that pipes leading to blind drains in the side wall were in many cases not completely filled. This was due to the fact that there were no vents for these pipes, and also that they had a downward slope. An unsuccessful attempt was made to grout many of these pipes. Finally they were hand-packed, which was accomplished by very tightly driving into the pipe a wooden plug and finally sealing the space between the end of the plug and the pipe with compacted cement balls. In some cases it was necessary to "hand-pack" several times before the leak was successfully closed. The results obtained in this way were satisfactory, none of the pipes showing leakage. After grouting was completed, any remaining leaks were calked with lead wool. The last high-pressure grouting was done on October 22. The inflow into the tunnel was reduced by grouting from 490 gallons per minute to 60 gallons per minute. A total of 7,279 cubic yards of grout was forced in under low pressure, and 343 cubic yards under high pressure. The volume of

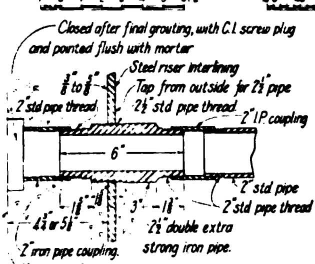


DETAIL AT RISER VALVE



SHAFT 5

L = Bell and spigot lead joint in riser interlining
V = Top (steel) flange of riser valve with lead gasket
F = Bottom (bronze) flange of riser valve



CONNECTION OF GROUT PIPE THROUGH RISER INTERLINING

BONDING SHAFT FILLING TO EXISTING CONCRETE

The existing concrete shaft lining was rough pointed so as to remove all mortar skin and expose coarse aggregate.

Before placing concrete shaft filling in any part of any shaft between the bottom of the cone and the valve chamber, the existing concrete, was cleaned, wet and brushed with mortar.

GROUTING CHANNELS AND GROUT PIPES.

Grouting channels were built of at least the number and as nearly as practicable in the positions shown on the drawings. Additional grouting channels were built as ordered to cover wet or seamy rock or defects, such as leaking joints, in existing concrete.

Each grouting channel is continuous as a full circle entirely around the shaft.

The grout pipes shown on the drawings are diagrammatic only. Not less than three 2" grout pipes were carried to each grouting channel in single riser shafts and not less than two to each half channel in double riser shafts. Grout pipes run separately, from the point of grouting to the channel, without intercommunication.

Individual grout pipes were carried to all wet or open seams in rock, and to holes drilled into the concrete at all leaks unless these seams and leaks were covered by grouting channels.

To avoid congestion of vertical grout pipes, all pipes from the necessary number of channels in any shaft were carried through the steel riser interlining with the connection shown. All joints through and near the interlining were tested at 300 pounds per square inch.

Both vertical and horizontal grout pipes clear all bronze pipes by not less than 2"

GROUTING SHAFT CLOSURE

The grouting channels shown on the drawings and other channels or pipes which were ordered for grouting leaks or seams were grouted to refusal with thin neat cement grout at a pressure of 300 pounds per square inch, except that channels in contact with the riser valve lever pockets were grouted at not more than 150 pounds per square inch.

Thick grout or grout containing sand, and lower pressures were used only for filling considerable voids which could not be filled with concrete, as where leakage of grout into the shaft could not be stopped with thin neat grout.

In order that shrinkage of the shaft filling was complete before grouting, the grouting channels shown on the drawings were not grouted until three months after completing the concrete shaft filling.

B.W.S. 1011

CITY TUNNEL—Shaft grouting method and details

grout in the supported portion of the tunnel averaged 2.03 cubic yards per foot of tunnel, and in the unsupported 0.26 cubic yard, the average for the entire tunnel being 0.34 cubic yard per foot.

As work was completed at the various shafts, they were prepared for final closure by removing the shaft equipment, cleaning the concrete lining and installing small concrete mixing plants. At Shafts 2 and 4 the main concreting plants used for lining tunnel were kept in service.

A timber platform supported by pins set into the rock and lining was first built. Then the concrete forming the riser-valve approach was started in two lifts; first, the cone section which contracted the waterway from a diameter of 14 feet to 4 feet, and then the goblet section, which increased the waterway from a cross-section of 4 feet to one of 5 feet 9½ inches, corresponding to that of the riser-valve seat. In niches in the top of the goblet section jacks were set, on which the riser-valve body was landed and brought to the exact elevation. After the riser-valve body was set, the lowermost section of riser-pipe was drilled to fit the holes in the upper flange of the valve and bolted. The riser-pipe in Shafts 2, 4 and 5 was of riveted steel in 20-foot lengths, 4 feet 9½ inches inside diameter, and ⅜-inch plate, except for the upper section, which was ½-inch plate. The field joints were of the bell-and-spigot type made by shop riveting a 3-inch by 3-inch by ⅜-inch angle on the outside and 3½ inches below the top of each length, and also a ⅝-inch reinforcing band on the inside, 6½ inches in width, its top flush with the end of the pipe. On the outside of the bottom of the pipe sections a ¾-inch reinforcing band four inches wide was riveted. The calking space was about ½ inch wide and four inches deep. The lead joints formed were highly satisfactory. The two riser-pipes and field joints in Shaft 3 were of similar construction except that the inside diameters were 7 feet 9½ inches and the upper section ⅝-inch plate.

As the riser-pipes were erected, the small bronze pipes for operating the riser valves were carried up with them. All pipes were accurately plumbed and securely held in position. After this the shaft was concreted to within about 15 feet of the top, and then the shaft-cap anchor-bolts were placed and concreted in, leaving the upper three feet free. As the shaft concrete was placed, grouting channels were left and grouted after the concrete had been in place long enough to insure complete shrinkage, for which two weeks were allowed. After concreting, the shaft caps were

PLATE 18

CITY TUNNEL—Inflow before grouting amounting to 85 gallons per minute through grout pipes in tunnel south of Shaft 4, Claflin terrace, The Bronx. Contract 63

PLATE 19

CITY TUNNEL—Looking down Shaft 3, Sedgwick avenue and 210th street, showing installation of 72-inch riser valves. Note operating mechanism at left of each; operating lever installed for right-hand valve, and in center, cable of thermophones to determine time-setting of concrete before grouting. Contract 63

set over and riveted to the riser-pipe and to the free ends of the anchor-bolts attached to the caps. The riser-pipes were lined with approximately five inches of concrete. Except at Shaft 3 the riser-pipes were not lined until the valve-chambers at the tops of the shafts had been built.

Before placing the riser-valve plug within the valve body which was already set in the shaft and concreted in, a collapsible wooden platform was placed below the valve. The tripod of the riser valve was lowered and centered on a staging built up from the timber platform. The plug was next lowered, its tail rod entering the tripod, and then the valve plug was locked into the breech-block mechanism between the plug and the body of the riser valve. The tripod was then raised up on the tail rod to within a fraction of an inch of its final position, and held there by a clamp around the tail rod beneath the tripod. The tripod footings and anchor-bolts were then attached and concreted in place. After this the bronze wedges between the footing and the pad of the tripod legs were driven in until the tripod head came to a bearing on the plug. The ends of the wedges were then cut off. In some cases adjustment in the setting was found necessary.

Excavation for the valve-chambers being made before the shafts were sunk, there was no delay in building the chambers after the shaft concrete was completed. The building of all these chambers was commenced and completed during the year.

All the shaft caps were placed during the year, being the only metal-work set so far in the valve-chambers.

The contractor's force averaged 265 men per day, exclusive of Sundays and holidays. The maximum employed was 514 men and the minimum was 54 men.

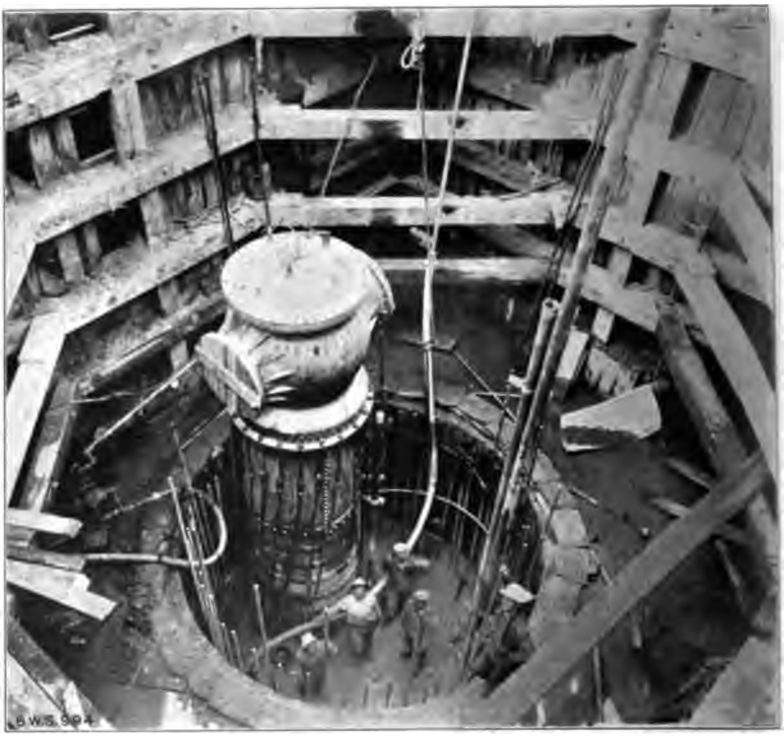
CITY TUNNEL—BURNSIDE AVENUE TO WEST 99TH STREET

Contract 65—Pittsburg Contracting Company, Contractor

This contract comprises 28,319 feet of pressure tunnel 15 feet and 14 feet in diameter and seven shafts, 6 to 12, inclusive. During the year the balance of the tunnel concrete lining was placed; nearly all of the tunnel was grouted, cleaned and calked; shaft closures were made at three shafts, and one valve-chamber was commenced. At the close of the year 92 per cent. of the contract as measured by the partial estimates was completed.

The tunnel concreting plants at Shafts 6, 8 and 10 continued in operation until the completion of the concreting work and the one at Shaft 12 throughout the year.

In concreting the drainage drift between the tunnel and Shaft 11 the two diaphragms were first set, and then the steel shell or interlining was erected in 13-foot sections on a sub-invert of concrete, the diaphragms being riveted to the interlining. The concrete between the rock and the interlining was placed separately for each 13-foot section of interlining. The inner lining of the drift was placed as with ordinary tunnel lining, the invert being followed by side walls and arch.



CITY TUNNEL—Shaft 7 and chamber. Bronze shaft cap riveted to 48-inch steel riser-pipe from tunnel. Contract 65

The concrete lining in the tunnel north of Shaft 12 for a stretch of 110 feet through soft and badly disintegrated rock was reinforced by a $\frac{5}{8}$-inch steel shell placed in rings 7 feet 4 inches long with flanged ends. Each ring was made up of three segments. A sub-invert of concrete upon which the steel shell was later erected, was placed, after which the segments were assembled south of the stretch to be reinforced, moved ahead on the sub-invert and connected to the ring previously set, using yarn grum-

mets treated with white lead around the bolts of the flange connection. After erecting a ring, the concrete between the shell and the rock was placed and all transverse and longitudinal joints were calked. All grout pipes in the steel roof support above the steel section were carried through holes bored in the steel shell with an oxy-acetylene flame. Holes were also drilled through the bottom of each ring, and 1-inch grout pipes tapped in. The steel

CITY TUNNEL—Drainage Shaft 11, Morningside park at 121st street. Note concrete outer lining, tile interlining and forms for placing concrete inner lining; also reinforcement for four concrete guides for drainage equipment. Contract 65

shell was lined by placing invert, side walls and arch in the order named. After the lining was completed, grouting was done through the bottom holes at 125 pounds pressure to fill the space between the steel and the sub-invert. The dry packing above the steel roof support was grouted under 125 pounds pressure and later by high pressure of 275 pounds per square inch. In the key of the inner concrete lining grout pipes were placed on each side of each pair of 4-inch flange angles.

Grouting was commenced at different points before the concreting was finished, six low-pressure and five high-pressure rigs being used. Stationary Ingersoll-Rand compressors, with a capacity of 300 cubic feet of free air per minute at 100 pounds per square inch, were used. At some locations these were installed on the surface; at others in the tunnel. For high-pressure grouting National compressors were used alone or as "boosters" with the Westinghouse high-pressure compressors furnished by The City. Only one tank was used in high-pressure grouting. The second tank on the car was used as an air receiver.

Grout pipes were placed about 30 feet apart in the arch and vent-pipes about 50 feet apart to high spots in the roof. In addition, deep-seated pipes were set and all leaks and open seams were treated as described under Contract 63. Low-pressure grouting was conducted in a manner similar to that described under Contract 63. The materials used in each batch were one bag of cement, 80 to 100 pounds of fine white beach sand and 8 to 10 gallons of water. Usually it was possible to force grout about 150 feet ahead of the pipe connected to. High-pressure grouting was carried on at a pressure of 300 pounds per square inch and the materials varied somewhat to suit conditions. As on Contract 63 grouting was started with a very thin mixture, one bag of cement to 25 to 50 gallons of water and gradually reduced to one bag of cement to five gallons of water. In the section of wet tunnel and broken up ground under the Harlem river, in several cases, it was found that the very thin batches were easily taken, but that the pipe refused when the mixture was thickened. A return to the very thin mixture often resulted in forcing several more batches into the hole. The inflow into the tunnel before grouting amounted to 243 gallons per minute and after grouting 31 gallons per minute. A total of 11,973 cubic yards of grout was forced in under low pressure and 7,279 cubic yards under high pressure. The volume of grout in the supported portion of the tunnel averaged 2.54 cubic yards per foot of tunnel and in the unsupported 0.50 cubic yard.

Shaft closures except at Shaft 12 were started and those at Shafts 7 and 9 were completed. The work was conducted in a manner similar to that under Contract 63 except that the riser-valve bodies were landed on short pieces of I-beams embedded in the concrete and brought up to elevation by thin steel wedges. The riser-pipes were lined after the shaft concrete had been placed and before the riser-valve plugs were set. Concreting the bottom of

CITY TUNNEL—4-foot 9½-inch steel riser-pipes alongside of Section-Valve Shaft 13, to convey water from either up-stream or down-stream portion of tunnel to surface mains at 93rd street and Central Park West. Contract 65

Shaft 11 was carried on simultaneously with the work in the drainage drift, concrete for both being mixed at the top of the shaft. The drainage interlining of 2-inch terra-cotta tiles was laid up against the outer lining of the shaft. On the face of this in order to prevent the entrance of mortar into the joints, a layer of water-proof material was laid and made to adhere by the application of heat or by the use of asphaltum applied to the tile. The forms were then erected and the concrete placed.

The valve-chamber at Shaft 7 was started, the floors and walls being completed. This shaft was sunk to rock as an open caisson and the chamber was carried by four reinforced-concrete cantilever beams resting on the shaft concrete.

The shaft caps at Shafts 7 and 9, and the bronze doors and accessories in the drift at Shaft 11 were set during the year.

The contractor's force averaged 513 men per day exclusive of Sundays and holidays. The maximum number of men employed was 1,136 and the minimum 145.

Manhattan Division

CITY TUNNEL—WEST 99TH STREET TO UNION SQUARE

Contract 66—Grant Smith & Co. & Locher, Contractors

This contract covers the construction of 23,140 feet of pressure tunnel, 14, 13 and 12 feet in diameter, and of six shafts, 13 to 18, inclusive. During the year the remainder of the tunnel lining, 318 feet, was placed, and the grouting of the tunnel finished. The shaft closures started in 1913 and the valve-chambers at the top of the shafts begun during the year were completed. The areas around Shafts 14, 15, 16 and 17 were cleaned up. At Shaft 14 final grading was done. Measured by the partial estimates for payment, the contract was 95 per cent. completed. Small plants at the top of shafts furnished concrete for the tunnel lining. Before completing the tunnel at the foot of Shafts 13 and 18, which are section-valve shafts, it was necessary to enlarge the tunnel section. The section valve, waterway castings, horizontal portions of the riser-pipes and steel interlining beyond the waterway castings were put in place and steel diaphragms were also placed and grouted within slots drilled for the purpose around the tunnel. The aggregate weight of the metal-work set at each of these shafts approximated 100 tons, the heaviest piece, the section valve, weighing 20 tons. To lower these the hoisting equipment was reinforced. The general order of setting the metal-work was first to erect the diaphragms and rivet to them the first lengths of steel interlining and

PLATE 21

Bronze reducer pipes suspended over Shaft 13 ready to be lowered into position. Contract 66

horizontal riser-pipe, after which the diaphragms were grouted in, concrete placed around the pipes set, and concrete placed over the entire bottom of the shaft area. The balance of the metal-work was then lowered and the horizontal riser-pipes completed and concrete piers built to support them. Next the section valve was set and the bronze and steel waterway castings on either side brought up and bolted, copper gaskets being used between the flanges. To form the closure between the sections of steel interlining previously set and concreted in and the sections next to the waterway castings, a lap-joint in the steel interlining was drilled. The field joints in the horizontal riser-pipes and the steel interlining, except the closed joint previously mentioned, were of the flanged type. Joints were bolted, and lamp-wick grummets treated with red lead were placed under the heads and nuts of all bolts. After the concrete linings were placed within the steel interlining, steel waterway castings and horizontal riser-pipes, the entire section of the tunnel at the bottom of the shaft, except for the 9-foot section-valve well, was concreted. The concrete was dropped from the surface through a 6-inch wrought-iron pipe to the foot of the shaft. After the completion of the work at the foot of these shafts, operations were started for filling with concrete the section-valve well for a hight of five feet above the dome of the valve.

High-pressure grouting which was in progress at the close of 1913 was completed on January 12, except at the bottom of a few of the shafts. The method of grouting was the same as in 1913. Grouting reduced the leakage from 124 gallons per minute to 17 gallons per minute. In all, 5,348 cubic yards of grout were placed under low pressure, and 734 cubic yards under high pressure. The volume of grout placed in the supported portion of the tunnel averaged 1.16 cubic yards per linear foot, and in the unsupported portion 0.25 cubic yard per foot.

The shaft-closure work at Shafts 14, 15, 16 and 17 was done in the same manner as under Contract 63. The first three shafts have each a 48-inch riser valve and the other has two 48-inch riser valves. These closures were practically completed by June. Shafts 13 and 18 contain two 48-inch risers and a section-valve well nine feet in diameter. These shafts differ from the standard waterway shafts in that the two riser-pipes extend from below the riser valves down into the tunnel to either side of the section valve, they contain a section-valve well with tile interlining and the section-valve stem is carried in a casing within the concrete. The work was further complicated because the shaft timbering placed during

CITY TUNNEL—Bronze reducer pipes suspended over Shaft 13 ready to be lowered into position. Contract 66

horizontal riser-pipe, after which the diaphragms were grouted in, concrete placed around the pipes set, and concrete placed over the entire bottom of the shaft area. The balance of the metal-work was then lowered and the horizontal riser-pipes completed and concrete piers built to support them. Next the section valve was set and the bronze and steel waterway castings on either side brought up and bolted, copper gaskets being used between the flanges. To form the closure between the sections of steel interlining previously set and concreted in and the sections next to the waterway castings, a lap-joint in the steel interlining was drilled. The field joints in the horizontal riser-pipes and the steel interlining, except the closed joint previously mentioned, were of the flanged type. Joints were bolted, and lamp-wick grummets treated with red lead were placed under the heads and nuts of all bolts. After the concrete linings were placed within the steel interlining, steel waterway castings and horizontal riser-pipes, the entire section of the tunnel at the bottom of the shaft, except for the 9-foot section-valve well, was concreted. The concrete was dropped from the surface through a 6-inch wrought-iron pipe to the foot of the shaft. After the completion of the work at the foot of these shafts, operations were started for filling with concrete the section-valve well for a hight of five feet above the dome of the valve.

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CITY TUNNEL—Bronze reducer pipes suspended over Shaft 13 ready to be lowered into position. Contract 66

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CITY TUNNEL—Bronze reducer pipes suspended over Shaft 13 ready to be lowered into position. Contract 66

horizontal riser-pipe, after which the diaphragms were grouted in, concrete placed around the pipes set, and concrete placed over the entire bottom of the shaft area. The balance of the metal-work was then lowered and the horizontal riser-pipes completed and concrete piers built to support them. Next the section valve was set and the bronze and steel waterway castings on either side brought up and bolted, copper gaskets being used between the flanges. To form the closure between the sections of steel interlining previously set and concreted in and the sections next to the waterway castings, a lap-joint in the steel interlining was drilled. The field joints in the horizontal riser-pipes and the steel interlining, except the closed joint previously mentioned, were of the flanged type. Joints were bolted, and lamp-wick grummets treated with red lead were placed under the heads and nuts of all bolts. After the concrete linings were placed within the steel interlining, steel waterway castings and horizontal riser-pipes, the entire section of the tunnel at the bottom of the shaft, except for the 9-foot section-valve well, was concreted. The concrete was dropped from the surface through a 6-inch wrought-iron pipe to the foot of the shaft. After the completion of the work at the foot of these shafts, operations were started for filling with concrete the section-valve well for a hight of five feet above the dome of the valve.

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CITY TUNNEL—Bronze reducer pipes suspended over Shaft 13 ready to be lowered into position. Contract 66

PLATE 22

CITY TUNNEL—66-inch bronze section valve suspended over Shaft 13 ready to be lowered into position. Contract 66

sinking had to be removed as concreting progressed. The concrete lining was not placed during shaft excavation as at the other shafts. In order to have the concrete lining and the concrete shaft plugs a monolithic mass, concreting was started from a platform about 20 feet up the shaft. One length was set of each of the pipes to be carried through the concrete, and a section of forms for the valve well 10 feet 4 inches in diameter placed and then concreted. In a similar manner the concreting proceeded in 10-foot lifts. Shaft concrete was then placed, the 2-inch tile interlining and waterproofing were placed around this well in a manner similar to that at Shaft 11 under Contract 65 forming a finished well nine feet in diameter.

The excavations for the valve-chambers were made before the shafts were sunk, allowing the building of chambers to be undertaken immediately after the shaft work was completed. The first chamber was started during July, 1913, and by the end of 1914 the work was practically completed.

The setting of valves and specials in the chambers at Shafts 14, 15 and 16 was completed.

The average force employed by the contractors, exclusive of Sundays and holidays, was 114 men per day, the variation being between 238 and 29.

CITY TUNNEL—UNION SQUARE TO BROOKLYN

Contract 67—Holbrook, Cabot and Rollins Corporation, Geo. B. Fry, Thos. B. Bryson, Contractors

This contract comprises the construction of the southerly portion of the City tunnel and includes 21,177 feet of pressure tunnel 12 feet and 11 feet in diameter, and six shafts, 19 to 24, inclusive.

During the year 16,274 feet of tunnel were lined, completing this work, grouting the tunnel was completed and the riser-pipes and shaft plugs were placed in all shafts except Shaft 22. In addition, all the junctions of shafts with tunnel were concreted; the special work in the drainage drift at Shaft 21 including the lining of the drift was completed and the inner lining in Shaft 21 was placed.

The contract was 89 per cent. completed as measured by the partial estimates for payment. The work remaining to be done included the placing of the riser-pipe and concrete plug in Shaft 22, construction of the chambers at the tops of the shafts, and the installation of the piping and valves in the chambers.

The tunnel concreting plants at Shafts 19, 21 and 22 were continued in operation. Two 1-yard mixers were installed at the top

of these shafts, each so arranged as to discharge the concrete directly into a car at either of the two cages. Only one mixer was used at any one time, the other being held in reserve. The sand and stone or gravel were dumped into pits below the street level at the shafts and the material elevated by bucket elevators into storage bins, from which the sand and stone were fed by gravity into the mixer through gaging hoppers. Cement from the storehouse was loaded by hand on a belt conveyor which delivered the cement to the charging platform. At Shaft 22 the stone used was obtained by crushing the granodiorite from the tunnel. After the concrete cars were lowered into the tunnel they were hauled to the forms in four or five-car trains by storage-battery locomotives. The usual method of placing side walls and arch by "trailing" forms was used, the arch form trailing about 1½ feet behind the side-wall form. In concreting a section of side wall and arch the concrete was first delivered to the working platform on the arch form by being hauled up an incline, and after being dumped the concrete was shoveled in place behind the arch form until it reached the key, when side-wall concreting was begun; thereafter, the keying of the arch and concreting of the side wall proceeded simultaneously, the keying being completed usually in from one to two hours after completion of the side wall. The concrete in the key was placed by working continuously from the old concrete towards the end of the arch form. The side-wall concrete was all shoveled from the platform into the side-wall forms which extended 2½ feet above the platform, thereby facilitating progress by decreasing the quantity of concrete to be placed behind the arch form.

For concreting the side walls and arch two sets of forms, 70 and 80 feet long, were used in the upper level north from Shaft 10, and three sets, 60, 70 and 80 feet long, in the lower tunnel south from Shaft 19. The forms were supported on and moved ahead by carriages which traveled on the completed invert, and designed so as to permit the concrete cars to be hauled through the form to the form beyond. All forms worked toward the shaft. As soon as one set of forms was filled the concrete gang moved to another form which had been made ready for concreting by the form gang. Very rapid progress was made in lining the tunnel from this shaft. A total of 6,288 feet of side walls and arch was placed, the average progress per day being 54 linear feet, and the best monthly record being 2,834 feet.

The methods used for lining the tunnel from the plants at Shafts 21 and 22 were the same as at Shaft 19. At Shafts 21 and

PLATE 23

CITY TUNNEL—Interior of concrete chamber at the top of Shaft 15, showing the bronze shaft cap with cover removed, and two 30-inch bronze gate-valves bolted to the side outlets of the shaft cap. Contract 66

22, four 60-foot forms were used at each shaft, two in each stretch of tunnel adjacent to the shaft.

The tunnel north and south of Shaft 21 was grouted, which completed the tunnel grouting under this contract. The standard equipment used in grouting consisted of a battery of two Caniff grouting tanks and two air-compressors capable of raising the pressure from 100 to 350 pounds per square inch, the outfit being mounted on a small flat car with a trailer behind, upon which the materials were stored. Compressed air was furnished through a 4-inch pipe-line, and a 2-inch line connected to the discharge of the tunnel pumps furnished water for grouting.

The tunnel was grouted in two operations, low and high-pressure grouting. For low-pressure grout batches of one bag of cement and an equal volume of sand with approximately eight gallons of water were used. This was forced into the key-pipes under a pressure not exceeding 90 pounds per square inch, the connections being made to pipes about 250 to 300 feet apart along the tunnel. Before the grout set hard, the high vent-pipes and pipes showing leakage were opened up for subsequent high-pressure connection. After the low-pressure grouting had been completed for a stretch, high-pressure grouting was started. For this work, neat cement grout consisting ordinarily of batches of one bag of cement and six gallons of water was used and forced into vent-pipes previously opened, and into pipes which showed leakage.

In grouting the wet stretch of tunnel near Shaft 23 where the special steel-shell construction was used in place of the ordinary pans, the drain under the invert was first grouted, then the "dry-packing" space between the steel shell and the rock was filled with low-pressure grout, after which the pipes seated into the rock seams were grouted under high pressure. The leakage of water into this 700-foot stretch amounting to about 290 gallons per minute before grouting was reduced to ½ gallon per minute after grouting. The leakage into the four miles of tunnel included in this contract is now about 19 gallons per minute against 539 gallons per minute before grouting.

Upon completion of grouting the tunnel stretches were cleaned and the junctions between shafts and tunnel were concreted. For constructing the quarter-bends at the foot of shafts and the roll-way sections at junctions of Shafts 19 and 22 with the upper levels of the tunnel, special forms were used consisting of wooden ribs covered usually with two thicknesses of 1-inch white-pine lagging previously soaked in water so that they could be readily bent around the ribs to the required curves.

After cleaning the tunnel the concrete plugs and riser-pipes were placed in the shafts. In concreting the plug at Shaft 20, the cone-shaped transition form at the bottom of the plug was first set up on timbers resting on the old cage timbers in the shaft. After the concrete was placed behind this form, the valve bodies for the two 48-inch riser valves were set and concrete placed around them. The bronze tripods through which the tail rods of the riser valves operate were then put in place, using for this purpose a steel cage setting frame. In placing the shaft plug the concrete was carried up in 15-foot lifts corresponding to the lengths of the sections of the two riser-pipes which were first placed. After three or four lengths of each riser-pipe had been concreted in, the joints between the sections of the pipes were calked by hand with lead wool and the concrete lining inside of the risers was then placed. Wooden collapsible forms were used for lining the risers. After the risers had been carried up to the top and lined, the bronze riser-valve plugs were lowered and set into place and the shaft caps were later riveted to the riser-pipes.

For the drainage drift at Shaft 21 the steel for the inner lining and diaphragms were lowered to the bottom and erected in place. After the cages and timbering in the shaft were removed the diaphragms were set in slots previously cut in the rock. With the exception of the joints in the riser interlining which were bolted together, all other connections in the steel were riveted. The tunnel side of the drift diaphragm was first concreted, the material being hauled through the tunnel from Shaft 22. The concrete lining inside the 10-foot-diameter pipe used for the interlining was placed behind special wooden forms set on the invert. In order to secure a monolithic arch the lining was placed in one operation above the invert, the concrete being shoveled in from the end where a bulkhead was carried up with the concrete. The space between the top of the concrete and the steel was subsequently grouted. The riser-pipe in the drift was lined with mortar placed by grout tanks. The concrete in the drift between the diaphragm and the shaft was mixed at the top of Shaft 21 and lowered down by buckets. After the 16-inch bronze pipe in the bottom of the drift was assembled in place, the floor concrete was placed over this pipe and up to within about six inches from the under side of the elliptical steel castings. This concrete was also extended under the steel riser-pipe, making a cradle for its support prior to lining it. The steel castings were then bolted to the

PLATE 24

CITY TUNNEL—Drilling diaphragm slot for end of steel lining of drift connecting waterway tunnel with Drainage Shaft 21 at Clinton and South streets. The lower drill is used to broach the slot cut by the Radialax machines above, operated by two men. Contract 67

bronze door-frame which had been previously riveted to the steel diaphragm, and the concreting between the shaft and diaphragm was completed. At the same time the gap left in the outer lining of the shaft at the drift was closed.

For placing the inner lining in Shaft 21, nine 5-foot sections of circular steel forms were used. The forms for the cage and float guides were of steel castings bolted securely to the circular forms. In order to maintain the alinement and accurate spacing of the float guides, 4-inch by 4-inch angles were bolted from the side of one guide form to the corresponding side of the opposite form, one near the top and the other near the bottom of each 5-foot section. Except near the bottom, the inner lining was placed in 5-foot lifts. The tile blocks forming the drainage interlining were carried up immediately in advance of the concrete lining, and to prevent the mortar from the concrete leaking into the tile channels a thickness of water-proof felt was laid and secured to the inside of the tile. For moving the forms, a hanging platform suspended from the forms above those being moved was used. After all the nine sections of forms were concreted, the lower six sections were removed and taken up to the top of the shaft, and the seventh section was then moved and immediately set up again on top of the two sections left in place. The forms at the top of the shaft were then lowered and set up successively as needed. The work was prosecuted continuously on all three shifts. The upper 670 feet of the shaft were lined at an average rate of 80 feet per week, the average for 725 feet of shaft being 58 feet per week.

At the close of the year, work was in progress dismantling shaft and tunnel plant, cleaning up, and making preparations for the construction of the chambers at Shafts 19, 20 and 24. At the last-mentioned shaft the floor of the chamber was laid. At Shafts 21 and 23, the work in the shafts was being completed, and in Shaft 22 cleaning up was in progress preparatory to placing the shaft plug and riser-pipe.

The average daily force employed by the contractors exclusive of Sundays and holidays was 373 men, the maximum 1,029 and the minimum 141.

Conduit and Reservoir Division

CITY PIPE-LINES—BAY RIDGE CONDUIT

Contract 75—F. V. Smith & Son, Inc., Contractor

This contract includes 16,293 feet of 48-inch cast-iron pipe

and extends from the southerly end of the completed Contract 87 at 36th street and Fifth avenue, Brooklyn, to the beginning of the Narrows siphon at 79th street and Shore road, Brooklyn. The work was practically completed at the close of 1913. The small amount remaining was completed January 28, and the work was finally accepted on February 17, beginning with which date one year of maintenance is required. The final estimate was $234,-550.60.

CITY PIPE-LINES—PART OF QUEENS CONDUIT

Contract 86—*Beaver Engineering and Contracting Co., Contractor*

This contract, for 2.4 miles of 66-inch steel pipe from Shaft 24 of the City tunnel to the westerly end of the completed Contract 103 near Broadway and Willoughby avenue, Brooklyn, was awarded April 28 and work was begun May 20. The amount of contract is $298,908.15. At the close of the year all pipe was laid and tested, all connections attached, the trench refilled with the exception of about 2,500 linear feet, and about 30 per cent. of the permanent pavement was replaced. The remainder of the pavement, the installation of operating and pressure-regulator devices, other miscellaneous metal parts, and the testing of the operation of gates remained to be completed.

The plant consisted of four hand-operated pipe derricks, one 30-horse-power gasoline-driven air-compressor with a capacity of 150 cubic feet of free air per minute, a 7-horse-power gasoline-driven pump housed on truck for hydrostatic tests, pneumatic riveting tools, rivet forges and miscellaneous equipment. A Moore trench machine, Model C, was leased at the beginning of the work and tried out on 1,800 feet of trench, but was found to be unsuited to this type of excavation and was discarded in favor of hand-work for the remainder of the trench.

The City provided an area of over an acre in the Wallabout Market site adjoining the canal, graded and fenced under the contract and used as a storage yard for steel pipe, valves, etc., in order that storage of large quantities of pipe in the streets and the consequent damage to them might be avoided.

The pipe trench was excavated seven feet wide to an average depth of about ten feet. Skeleton bracing was placed about every 25 feet, but sheeting was not used except where sand was encountered or the trench was unusually deep. Very little sheeting was left in place. The material encountered was sand, gravel and clay

and the back-filling was very economically and efficiently flushed and puddled into place. Excavation was started June 12 and completed November 9. Back-filling was continued to the middle of December when freezing weather prevented its completion. About 2,500 feet of trench remained open.

In order to determine the value of various protective coatings, the pipe was coated and covered with the following materials for the lengths of pipe given: (a) Mineral rubber coating "Sarco", 3,600 linear feet; (b) Mineral rubber coating "Sarco" and one layer of burlap, 2,802 linear feet; (c) Mineral rubber coating "Sarco" and two layers of burlap, 1,819 linear feet; (d) Bitumastic solution, three coats, 1,115 linear feet; (e) Bitumastic solution, two coats, and one coat of bitumastic enamel, 2,740 linear feet.

In addition to these coatings, various kinds and mixtures of paint were applied in short stretches over a total of 60 linear feet of pipe.

The pipe in 30-foot lengths was brought into Wallabout canal opposite the yard and was unloaded by scow derrick onto elevated skids and rolled into the yard. When required they were rolled out upon the same skids onto heavy reach trucks, which hauled them to the point where they were to be laid. Here the loaded truck was driven under a high timber "gallows," which was provided with a chain hoist and was itself on wheels. A length of pipe was lifted clear of the truck and lowered to skids which rested on the pavement. The "gallows" was then rolled ahead to receive the next pipe, and the pipe just unloaded rolled by hand on skids until in place over trench, then lowered by means of two pipe derricks into the trench. The pipe was connected to the one last laid, set to line and grade, no blocking being used, and then held in place by 20 bolts at each joint. Pipe laying was begun on July 11 and completed on November 13. The maximum daily progress in pipe laying was 360 linear feet, or 12 lengths of pipe, and the average progress, exclusive of Sundays and holidays, was 113 linear feet.

At three street intersections, where existing structures made it necessary to depress the pipe-line, 48-inch cast-iron pipe was substituted for steel in the form of short siphons. This greatly facilitated the laying of pipe.

Riveting and calking were completed December 5, pneumatic tools being used. One riveting gang of seven men and two calkers averaged between four and five joints per day.

Five tests were made embracing the entire line, except about 95 feet adjoining Shaft 24, where a Venturi meter and 48-inch cast-iron pipe are located. Most of the leakage occurred at rivets and was taken up by hand calking under test pressure. The allowable leakage was three gallons per linear foot of pipe per 24 hours.

Contractor's maximum daily force was 358 men on October 6 and the average daily force was 175 men.

CITY PIPE-LINES—NARROWS SIPHON

Contract 99—Merritt & Chapman Derrick & Wrecking Co., Contractor

This contract includes the construction in New York harbor of a 36-inch flexible-jointed cast-iron submarine pipe-line, about 10,570 feet long, extending from 79th street and Shore road, Brooklyn, to the junction of Arrietta street and Stuyvesant place in Staten Island.

The contract was awarded February 24 and work was commenced March 4. The amount of the contract is $996,862.75.

During the year the casting of pipe was completed, the machining of the pipe about 85 per cent. finished, 4,600 linear feet of trench were excavated totaling about 318,000 cubic yards, 4,500 linear feet of pipe were laid and about 1,300 linear feet of trench were refilled. An extended series of experiments was also made, resulting in an improvement in the design of the joint, the sea-wall on the Brooklyn shore removed, a short piece of land trench opened on the same shore, and the first 1,400 feet of submarine pipe tested.

The amount of work completed during the year was 40 per cent. of the amount of contract.

The plant included a powerful dredge with a 6¼-yard clam-shell bucket, two tugs and seven dumping scows, a 70-ton derrick scow with steel skidway for laying pipe, two other derrick scows, and a 35-ton derrick tug. A launch and surf-boats were also provided.

Experiments to determine the efficiency of the proposed joint were carried on in several shops and at the contractor's yard at Stapleton. The experiments developed that the joint was deficient in lead and lacked the longitudinal strength necessary to withstand laying and temperature stresses. Various changes in the position of the gib screws (for forcing in the cold lead pellets) and the middle ridge of the spigot were then tried, and finally a

NARROWS SIPHON—Clam-shell bucket dredge excavating trench in which a 36-inch flexible-jointed cast-iron pipe-line between Brooklyn and Staten Island is being laid and covered. Contract 99

second row of gib-screw holes was added. A complete contact was obtained between the lead and the bell, and the amount of lead which could be injected was increased from 8 to 21 pounds. Thus a joint was developed that was not only tight and flexible but strong longitudinally.

Twenty-seven separate experiments with numerous strength and leakage tests were made, covering a period of about three months. During all of these experiments efforts were made to develop mechanical means for forcing in the lead, which became the more important as the quantity of lead increased. Air-drills for forcing in and backing out the gib screws proved a distinct improvement over the original method of using hand wrenches to turn the gib screws. Hydraulic plungers operated directly against the lead were then tried, and decreased the actual time of forcing in all the pellets to about half an hour after the plungers had been rigged up. But on account of the delays necessary to rig up the special high-pressure connections there was no time saved. Four Ingersoll-Rand "Little David" air-drills attached to a ring, which revolved around the bell of the joint to be made up, gave the simultaneous use of all drills and reduced the gross time of calking to less than ¾ hour per joint.

In the manufacture of the pipe particular pains were taken with the bells to obtain a spherical and smooth face in order that the lead would revolve true and free against the inside surface of the bell. The allowance from true sphericity was limited to 0.01 inch, and the inside face was ground to extreme smoothness by emery-wheels attached to a flexible shaft.

Each length of pipe was coated at the shop inside and out with a protective coat of bitumastic solution. On its arrival at the yard a second coat of solution and a coat of bitumastic enamel were applied. The latter coatings were applied at the storage yard and finishing touches to each pipe were applied just previous to laying.

Excavation was started April 8 on the Brooklyn shore. The sea-wall with underlying riprap was removed and a trench sufficiently wide to contain a derrick boat excavated. A short stretch of sheeted trench to contain the shore end of the submarine pipe was also opened up.

Dredging operations were commenced August 24, work being started at the Brooklyn shore. Government regulations restricted the minimum depth of the trench across the Bay Ridge channel to

about 59 feet below mean sea-level, thus determining the minimum grade for some distance out beyond the channel. The depth of trench varied from 10 to 35 feet, and efforts were made to get a minimum section that would stand open during the interval of from one to two months which must elapse between dredging and pipe laying. This time interval was essential on account of the sea-room necessary between the dredge and the pipe-laying scow.

In order to determine the minimum section of trench, a bottom width of 10 feet was at first adopted, and as the dredging proceeded cross-sections of the trench were taken to determine what slope the material would take. It was found that for a short time very steep slopes could be obtained, but later these would break down and fill the bottom of the trench. Portions of the trench were dredged several times and the bottom width after repeated trials increased to 30 feet. Where heavy cutting was encountered the trench was excavated in two lifts. The first lift was removed to a point 10 feet above grade with a bottom width of 70 feet, after which the remaining prism with a bottom width of 30 feet was taken out. The total amount of excavation to date is equivalent to a section having a bottom width of 20 feet with side slopes of 1 on 2.

The dredge used was of the clam-shell type, 40-foot beam and 120 feet in length, with 500-horse-power engines. A hard-bottom clam-shell bucket weighing 26,000 pounds, with a capacity of 6¼ cubic yards, was used. The average daily output working three 8-hour shifts was 3,800 cubic yards. Six-pocket bottom-dumping scows, having a capacity of 1,000 cubic yards, were used for the removal of the dredged material. These scows while being loaded were attached to and handled by means of winches on the dredge. A sufficient number of empty scows were kept moored adjacent to the work, and were towed to the dredge by a serving tug, after which they were hauled to sea and dumped.

In order to obtain the absolutely smooth trench bottom necessary for laying the pipe an "A"-shaped drag was constructed of 24-inch I-beams having a length of 25 feet and width of 20 feet, and a total weight of about six tons. This drag, slung from an empty scow in such a manner that the depth could be adjusted, was hauled along the bottom of trench by three tugs during slack-water periods. Excellent results were obtained and pipe afterwards laid contained few vertical deflections.

While the experiments on the joints were being made, apparatus for laying the pipe was assembled and made ready for use. A structural-steel cradle or skidway was constructed, resembling a through truss bridge curved in a vertical plane. This cradle is composed of 13 panels each 12 feet long and with a 5-degree angle between each panel. It is 168 feet long, 8 feet wide and 10 feet high, and weighs about 60 tons. The pipe is held in position on the cradle by three guides, one at the bottom and one at each side. The cradle is supported by cables on a trunnion cantilever over the forward end of the scow, and consequently trails lengthwise under it. The scow is 40 feet wide by 125 feet long, is held in position by 10 anchors and carries a 70-ton derrick. Each cable is led to a power-operated drum. Due to shallow water at the start it was impossible to carry the cradle from the forward end of the scow as the latter could not be moored over the cradle. The cradle was accordingly supported over the side of the scow by the derrick.

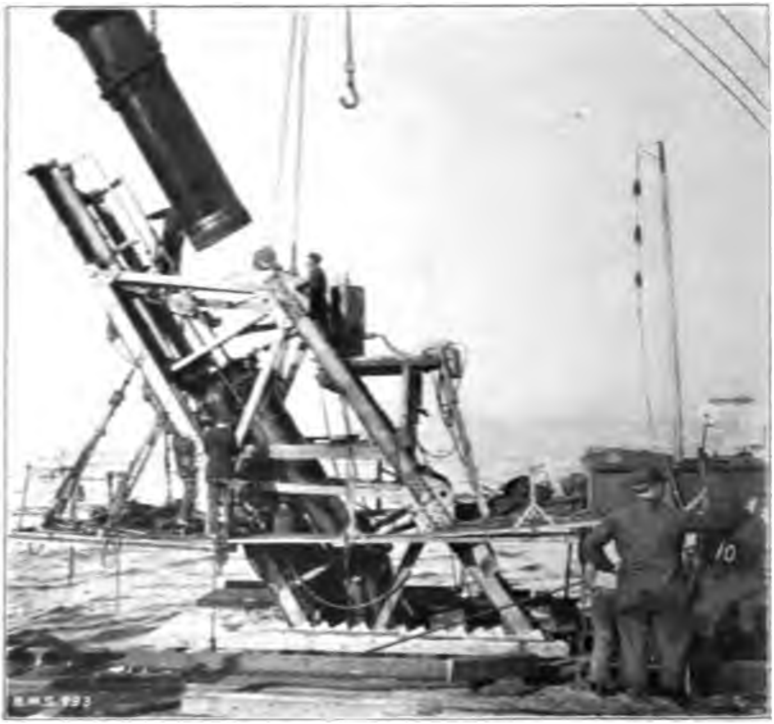
In conjunction with the pipe-laying scow, a second derrick scow, 100 feet long and 40 feet wide, was used for the storage of extra pipe, etc. The derrick of this scow was used to lift pipe into position on the cradle, and the other miscellaneous work in connection with the laying.

The general process of making up a joint was as follows: A pipe length was lifted into place on the cradle with its spigot end in position in the bell of the preceding pipe length. After wedging the snake, the joint was poured, using approximately 300 pounds of lead per joint. The snake was then removed, the air-machines placed in position and lead pellets forced into each gib-screw hole; a total of 112 lead pellets weighing 21 pounds was forced into each joint in this way. Grease containing 20 per cent. of graphite was then forced into all holes to lubricate the joint and make it flexible. The pipe coating was then applied to uncovered portions of the pipe and the pipe was then ready for lowering.

During the progress of pipe laying, the contractor was required to test each pipe joint before submergence, under a hydrostatic pressure of 200 pounds per square inch. After 129 joints had been tested and it was found that no leakage occurred, and in view of the satisfactory hydrostatic and air test to which 1,400 feet of the pipe as laid were subjected, as described later, the only joints tested were those directed by the Engineer.

During the making up of the joint the pipe was held fast

to the skidway by cables and upon completion of the joint was transferred to the hangers and the skidway cables were removed. A sufficient pull was kept on the pipe to support the suspended weight and keep it from crowding down on the pipe in the trench. The rear cables were then slackened and the forward cables wound in, thus moving the scow ahead slowly, and allowing the pipe to slide gently down the skidway to the bottom of the trench.



NARROWS SIPHON—Lowering 12-foot length of 36-inch cast-iron pipe for pouring flexible joint. At upper working platform of skidway note lead-melting pot. Men below main platform are applying bitumastic enamel. Contract 99

The average time of making a joint and lowering a 12-foot length complete was about three hours, thus making the average number of joints laid per 8-hour shift about 2½. This does not include delays on account of weather conditions, or other contingencies. The average force employed on the pipe scow per 8-hour shift was 25 men. This does not include the force employed on the various auxiliaries transporting men, materials and supplies, and moving anchors, etc.

Refilling of trench was to a depth of eight feet over the top

of pipe. Two kinds of refill, one of selected and one of unselected material, were placed. Only a small quantity of material from trench excavation was used, as dredging for the season was practically completed before back-filling commenced. Subway and foundation excavation was used and proved to be excellent material for this purpose.

Refilling was started November 19. On account of the lateness of the season, and possible injury to the pipe-line by anchors, refill was placed as quickly as possible. The refill material was brought to the site of the work in bottom-dumping scows, which were dumped at slack water over the pipe-line. Scows containing fine material were dumped in advance, covering the pipe to a depth of several feet, and the coarser material deposited on top. In general, the material leveled itself after reaching the trench bottom. Frequent soundings were taken to govern the depth as the work progressed.

A mooring scow with four anchor lines was used for holding the refill scow in position during dumping.

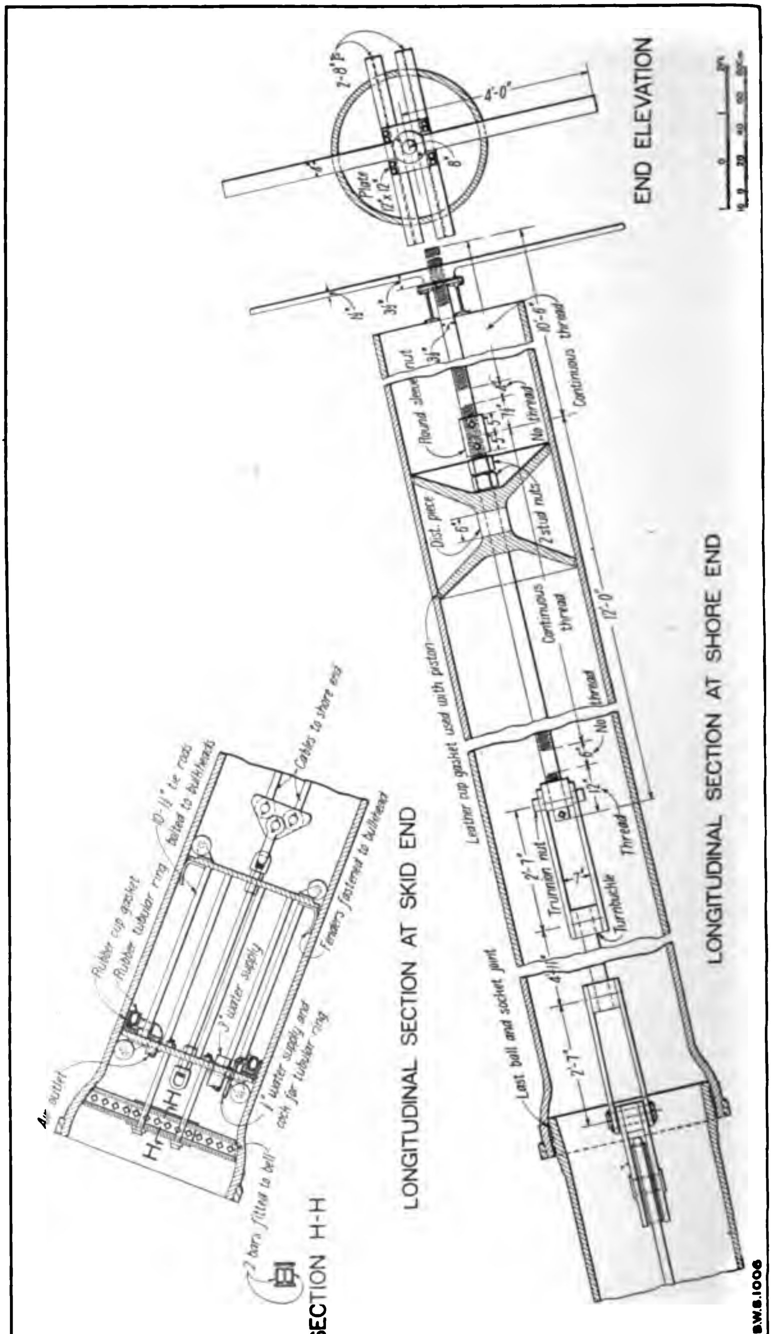
After 1,400 feet of pipe were laid, the pipe-line was subjected to a hydrostatic test in order to determine whether an acceptably water-tight joint could be procured without submarine calking.

The best method of putting the pipe under a test which would represent actual working conditions as nearly as possible was studied carefully. To test the pipe by simply bulkheading both ends was not considered advisable as the 130 pounds per square inch would place the end joints in a tension of 110 tons—a condition not approached in actual use. To avoid this tension it was decided to place a bulkhead at the bottom of the skidway and connect it by means of two 1⅜-inch cables to a bulkhead at the shore end.

The shore bulkhead was a piston 36¼ inches in diameter moving in a cylinder 10 feet in length provided with apparatus for taking up the slack and putting an initial strain on the cables. This cylinder was designed for use with less cable than used in the test, which necessitated an initial strain of considerable amount to get the required pressure on the line before the piston had taken its full travel.

The pressure was run up to 134 pounds per square inch on October 27, and the line was apparently tight. On the next day the test was resumed and a leakage of 50 gallons per minute at 105 pounds per square inch was found. On October 29 the air test was made and two leaks were found, the principal one near

SHEET 13



NARROWS SIPHON. Apparatus used in testing tightness of 1,000 foot stretch of laid pipe in harbor bottom

the bottom of the skidway. Examination by a diver showed a buckling of the pipe, one in the vertical and the other in a horizontal plane. This condition was relieved by pulling the pipe into line by cables from derrick lighters and then holding them in line by permanent cradles lashed across the two leaky joints. During this repair a 40-pound piece of lead was sheared off the joint near the skid. This was made up for by injecting lead slugs and calking with lead wool, in place, 60 feet under water.

A second hydrostatic test was made November 11, the intervening time being spent on repair of the buckled joints. In this test no pressure over 100 pounds per square inch was used.

The test gave a leakage of 4.5 gallons per minute at 100 pounds per square inch, 5.5 gallons per minute at 90 pounds per square inch, and 6.5 gallons per minute at 80 pounds per square inch, decreasing with increased pressure, which, between certain limits, is believed to be characteristic of this particular joint. Without relieving the water pressure below 60 pounds per square inch, air pressure was substituted, the water forced out, and an inspection made the following day. No leaks were found. About 1,400 feet of pipe with 118 joints were included in the tests.

On account of the long stretch of pipe-line in the water means were taken to keep the alinement and to determine the location of various points at considerable distance from shore.

The newly reclaimed land inside of the Bay Ridge sea-wall offered ideal sites for the location of observation points. Four points along the sea-wall were established from which all points along line could be observed and careful surveys were made to connect these points and tie them in with adjacent United States Coast and Geodetic triangulation stations. Other points on the Staten Island shore were selected and connected up with this system. The location of all soundings, etc., was determined by observation from the Bay Ridge sea-wall.

Tables were also computed so that men stationed on the scows could determine their exact location by means of sextant observations taken on the sea-wall points. By these methods the entire progress of each plant unit was determined and controlled. Range poles 30 to 55 feet high were established on center line and parallel lines at both Brooklyn and Staten Island sides. The ranges and observation points were kept lighted at night and could be used at all times except in very thick weather. Three ranges on pile platforms were established by the contractor several thousand feet from shore. These ranges were used in dredging to some extent,

but did not last long as passing vessels soon destroyed them. Cross-sections, profiles, etc., were taken at frequent intervals along the line of the trench in order to obtain records and determine any changes that might take place at the bottom. These data were obtained by soundings taken from a rowboat rigged up for this purpose. This boat was controlled by means of a connecting line, attached to a firmly anchored buoy at one side of the trench. The connecting line was also buoyed by cork floats spaced at 10-foot intervals and by this means the distance between soundings could be readily determined. A launch was used for moving the buoys, anchors, etc. From time to time signals were shown on the sounding boats and the location of these cut in by observers stationed on the shore.

The contractor's force averaged 56 men per day, exclusive of Sundays and holidays. The maximum force was 157 men and the minimum force was 2 men.

CITY PIPE-LINES—PART OF RICHMOND CONDUIT

Contract 88—*Beaver Engineering and Contracting Co., Contractor*

This contract is for the construction of that portion of the Richmond conduit between the west end of Narrows siphon and the north end of Richmond Conduit tunnel, and consists of 4,092 feet of 48-inch cast-iron pipe in Richmond borough. The contract was awarded on May 19, the amount being $70,186.60. Work was begun on May 22, and was completed on December 14, the final estimate amounting to $67,386.63. A year's maintenance is now in progress.

A 32-ton Bucyrus revolving traction shovel with a 7/8-yard bucket was used over the entire length of the contract except for about 500 feet in hard serpentine and for about 600 feet on the northerly end of the contract, where either traffic conditions or the treacherous nature of the banks made its use impracticable. The pipe was unloaded from barges at the Municipal dock, Stapleton, about two miles from the work, by lighters, and transferred directly to 5-ton Pierce-Arrow auto trucks which conveyed it to the work. A portable compound "A-bent," upon which was mounted a 5-ton duplex Yale & Towne block, was used to raise the pipe from the truck and deposit it upon the street. A 4-leg collapsible pipe derrick was used in laying the pipe in the trench.

Steam-shovel excavation starting late in June near First avenue on Richmond turnpike was pushed rapidly to the southerly end of the contract. Poles and wires interfering with the working

PLATE 26

NARROWS SIPHON—Submarine pipe skidway in winter storage. Note iron sheet between trusses at rear end to assist sliding, balancing tank and hinged deflector intended to push pipe down as it leaves skidway. Contract 99

of the shovel were removed by the public service companies, and the north-bound trolley track was abandoned at intervals. Considerable hand excavation was required to grade and trim the trench and at bell holes.

Pipe laying was carried on by a gang of 10 men and a foreman, laying an average of eight 12-foot lengths per day reaching a maximum of 23 lengths per day. An average force of four calkers was employed on the lead joints. Approximately 130 pounds of lead were used per joint. Connections were made with existing mains at Stuyvesant place, Westervelt avenue and at Jersey street, and 6-inch hydrants and 12-inch blow connections to sewers were installed. Refilling was done largely by puddling and flushing, except where the use of disintegrated rock required tamping.

As the borough authorities proposed to lay new pavement at two locations the pavement at these places was not restored except that the concrete foundation was replaced at one of these locations.

An 8-inch sewer lying in the west side of the trench for a greater portion of the contract, which was thought to be abandoned, was found to have a large number of house connections in use, necessitating the diversion of these connections to the central sewer of Richmond turnpike, after which the 8-inch sewer was destroyed.

The line was tested with a pressure maintained for 20 minutes and equal to that from a head of water at Elevation 295, that of Hill View equalizing reservoir, with an allowable leakage of two gallons per linear foot of pipe joint per 24 hours. The southerly section was successfully tested on October 3. The northerly section on preliminary tests exceeded the allowable leakage and about 40 joints were uncovered and recalked, and on October 23 this section was successfully tested, after which the line was unwatered and all valves tested.

SILVER LAKE RESERVOIR AND PART OF RICHMOND CONDUIT

Contract 89—Beaver Engineering and Contracting Co., Contractor

This contract is for the construction of Silver Lake reservoir, about 2,400 feet long and 1,200 feet wide, together with gate-chamber, conduits and other appurtenances, and Richmond Conduit tunnel, 1,200 feet long, extending from the northeast corner of the reservoir to the south end of Contract 88, in the Borough of Richmond.

completed to Elevation 212, and the West dike to Elevation 235.

On the South dike practically no fill was placed with the exception of the material excavated from the conduit trench. Refill over the South conduit at the dike was puddled.

The Laurel Avenue approach, a highway to be constructed in connection with the roadway across the Middle dike, was raised to subgrade, the material being obtained from the North Basin borrow-pit. No fill was placed on the Middle dike.

Upon completion of the North Dike core-wall, the rolled embankment for this dike was started and all earthwork concentrated here.

On August 25 the 32-ton Bucyrus shovel began excavation in the North basin, occasionally loading wagons and trains. The maximum number of trains operated was three of eight cars each. The shovel also refilled over Richmond Conduit tunnel and leveled over excavated area.

The required riprap protective covering for the water faces of the dikes was carried up with the earthwork of the North and West dikes, the West dike being practically completed and the North Dike riprap carried to the elevation of the top of the earth fill. The stone was obtained from the borrow-pits and also separated out from the earth on the dikes and hauled into place.

At the beginning of the year excavation of Richmond Conduit tunnel had proceeded about 300 feet from the north end. The material was serpentine of varying hardness. The method of excavation most frequently used was to bore three holes about three feet long with hand augers in the lower portion of the heading and with a small charge of dynamite blow out this bottom cut, after which the upper part of the face was broken down with picks. The average amount of dynamite used per foot of tunnel was 0.8 pound. For the first 188 feet the tunnel was supported by permanent timbering, 10-inch by 10-inch posts and caps, spaced about five feet apart with side lagging of 2-inch plank and with poling boards. Steel channels were also used for lagging the roof, the bents being spaced about 9.3 feet apart. Square sets were used throughout. The roof of the tunnel near both portals was carried three feet higher than in the remainder of the tunnel to give headroom for placing concrete over the reinforcement in these sections. Tunnel leakage was 65 gallons per minute, mainly from clayey seams near the south end. The tunnel was holed through on March 30, being driven in a little less than four months at an

clearing, grubbing, removal of top-soil, and the placing of fill on the down-stream embankment of the North dike. Silver lake was lowered to Elevation 189 ±, about 14 feet below its former level, having been drained through the gate-chamber out and the North conduit.

The borrow-pit in the North basin was excavated by the 76-ton Bucyrus shovel and was developed in a series of terraces running parallel to the projected flow line, the first cut being made approximately along the line of the existing 228-foot contour, with the other cuts stepping down to the bottom of the basin. The average cutting was about 20 feet. At first all material excavated was sent to the West Dike fill in trains of 6, 8 and 10 cars, pushed up grade by two Vulcan 18-ton locomotives. The material excavated in the pit was nearly all of suitable quality for rolled embankment, though occasional sand pockets were encountered, one of which furnished between 500 and 600 cubic yards of sand for concrete.

In the south approach cut to the tunnel portal the 76-ton Bucyrus excavated down to 10 feet above the required subgrade, and within a minimum of 20 feet. The 32-ton shovel, using long dipper sticks, then completed the trench. It was supported on 10-inch by 10-inch timbers 20 feet long and spanning the trench, the shovel shifting the timbers ahead as the excavation progressed, the sides of the excavation standing firm without sheeting. An advance of about 150 feet a day was made. The small shovel opened up 900 feet of trench in this manner and left only light trimming to bring excavation out to the required lines.

In the excavation for the gate-chamber, the big shovel removed the bulk of the material, which was a badly disintegrated serpentine, with an average cover of 10 feet of clayey earth. The maximum cut required in the gate-chamber was 31 feet, the shovel removing material to within two feet of subgrade. The excavation was completed by pick and shovel, using skips which dumped directly into wagons by a large derrick brought from the cut-off trench and erected at the west side of the cut.

In the South basin stripping and shallow-flowage excavation by the 76-ton shovel were in progress, the material from the excavation being used to cover the bed of peat at Silver lake to a minimum depth of two feet.

The North Dike cut-off trench, 380 feet long, was excavated partly in earth and partly in rock, the maximum depth in earth

completed to Elevation 212, and the West dike to Elevation 235.

On the South dike practically no fill was placed with the exception of the material excavated from the conduit trench. Refill over the South conduit at the dike was puddled.

The Laurel Avenue approach, a highway to be constructed in connection with the roadway across the Middle dike, was raised to subgrade, the material being obtained from the North Basin borrow-pit. No fill was placed on the Middle dike.

Upon completion of the North Dike core-wall, the rolled embankment for this dike was started and all earthwork concentrated here.

On August 25 the 32-ton Bucyrus shovel began excavation in the North basin, occasionally loading wagons and trains. The maximum number of trains operated was three of eight cars each. The shovel also refilled over Richmond Conduit tunnel and leveled over excavated area.

The required riprap protective covering for the water faces of the dikes was carried up with the earthwork of the North and West dikes, the West dike being practically completed and the North Dike riprap carried to the elevation of the top of the earth fill. The stone was obtained from the borrow-pits and also separated out from the earth on the dikes and hauled into place.

At the beginning of the year excavation of Richmond Conduit tunnel had proceeded about 300 feet from the north end. The material was serpentine of varying hardness. The method of excavation most frequently used was to bore three holes about three feet long with hand augers in the lower portion of the heading and with a small charge of dynamite blow out this bottom cut, after which the upper part of the face was broken down with picks. The average amount of dynamite used per foot of tunnel was 0.8 pound. For the first 188 feet the tunnel was supported by permanent timbering, 10-inch by 10-inch posts and caps, spaced about five feet apart with side lagging of 2-inch plank and with poling boards. Steel channels were also used for lagging the roof, the bents being spaced about 9.3 feet apart. Square sets were used throughout. The roof of the tunnel near both portals was carried three feet higher than in the remainder of the tunnel to give headroom for placing concrete over the reinforcement in these sections. Tunnel leakage was 65 gallons per minute, mainly from clayey seams near the south end. The tunnel was holed through on March 30, being driven in a little less than four months at an

average rate of 320 feet per month, or 4.4 feet per shift. The maximum advance made in one week was 100 feet.

Concreting was done from a plant at the north portal with the exception of about 100 feet near the south portal. Materials hauled up a ramp to an elevated platform were discharged into bins which fed by gravity a measuring hopper. From a 1-yard Smith mixer the concrete was discharged through a chute into ½-yard Koppel dump-cars, the latter being pushed through the tunnel by hand. On inclines a hoisting engine and cable pulled the cars. Drainage was cared for by a wooden box drain six inches by eight inches, removed before the blow-off invert was placed.

In general, concrete was placed in four operations, namely: Blow-off invert, blow-off side wall and arch, conduit invert and conduit side walls and arch. Concreting proceeded from the south end toward the north. The blow-off invert was placed continuously in stretches of 100 feet each. The blow-off side wall and arch and conduit invert were placed in 40 or 50-foot sections, and the conduit side wall and arch in 24-foot lengths. Concrete was dumped directly from cars into the forms except in the conduit arch, where it was shoveled into place. The mixture used throughout the tunnel was 1 : 2 : 4. Stone for dry packing over the reinforced sections at both ends of the tunnel was pushed on a specially constructed flat car over the completed tunnel concrete. This small car had been previously used over the forms in placing arch concrete in the reinforced sections and was improvised to meet the condition of the 3-foot headroom.

For grouting, a No. 2 Douglas force pump with a 2-inch discharge was used with a mixture of equal parts of cement and sand. It was impracticable to force grout with this machine through more than 25 feet of the dry packing, and it was found that forcing grout through more than the 75 feet of 2-inch pipe was a slow process requiring repeated cleaning of line. Brick cut-off walls were built every 100 feet and grout and vent-pipes spaced every 25 feet. The grouting machine had to be set up outside of each completed section for grouting as the bore of the conduit was but four feet. The stretch of about 250 feet of conduit and blow-off in open cut outside of the north portal was about half completed.

The contractor's force averaged 203 men per day, exclusive of Sundays and holidays, and reached a maximum of 316 men on July 11. Of this force an average of 31 men was employed on the tunnel and the balance on the reservoir.

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SANITATION

HERBERT D. PEASE, M. D., and ANDREW J. PROVOST, JR., C. E.,
Sanitary Experts

The employment of the Sanitary Experts for supervising all sanitary matters in connection with the work of the Board was continued for the year. The methods of supervision and control of previous years were followed.

David S. Flynn, M. D., continued as field representative. The laboratory organization and equipment provided for physical, chemical and bacteriological examinations of water, milk and other foods, sewage effluents, filtrates, etc., medical diagnostic examinations, including Widal reaction, sputum examinations, throat cultures and examinations of other clinical specimens.

Investigation was made of the rules and regulations in use for the sanitary protection of watersheds in various American and European supplies.

The studies begun in 1912, relating to the sanitary conditions on the Esopus watershed, were continued, and further studies were made of the sanitary quality of the water in Esopus creek and some of its tributaries. The five regular sampling stations between Boiceville and Pine hill were occupied throughout the year, and complete sanitary analyses, chemical, physical and bacteriological, were made on 70 samples taken at these stations, the average interval being 3 7/10 weeks. Three temporary stations were occupied in November on the Ox Clove and the Stoney Clove, tributaries of the Esopus creek.

The total number of samples analyzed at all stations during 1914 was 73.

Conferences were held and recommendations were made with respect to proposed legislation which will confer on the Board additional power for the sanitary control of the watersheds under its jurisdiction.

Conferences were had with the Commissioner of Health of New York City with regard to furnishing biological products for immunization and treatment of infectious diseases, and with local State health officers with regard to treatment and isolation of infectious diseases among Board employees and inhabitants adjacent to camps and those on watersheds of public supplies.

EXAMINATION OF CAMPS, SUPPLIES AND EFFLUENTS

The scope and methods of procedure for the conduct of this work were continued as described in the 1910 annual report.

Camp Sites were examined and reported on for Contracts 76, 151 and 160.

Housing Plans and Structures for cook house and ovens and modification of sewerage system for Contract 89 were examined and reported on.

Water-Supplies Examined.—Ninety-one samples in all were taken, apportioned as follows: Reservoir department, 85; Southern Aqueduct department, 5; and City Aqueduct department, 1.

Milk Supplies.—The milk supplied for the main camp, Contracts 3 and 10, from various sources, was examined and reported on in April, July, August and September. Other examinations of milk were made in connection with investigations of typhoid in the Reservoir department. The total number of samples analyzed was seven.

Sewage Effluents.—Examination was made of the sewage wastes from an institution in the Kensico watershed. One sample of sewage effluent was analyzed.

MAINTENANCE

As heretofore, frequent inspections were made along the entire line of the work for observation of sanitary operations, health conditions, etc. In connection with these inspections numerous conferences were held on the ground with division engineers, section engineers, contractors, their superintendents and physicians, and were made the subject of report. The special precautions heretofore adopted with respect to the care of labor housed or employed on watersheds were continued. Treatment by chlorinated lime of the supplies drawn from Croton lake and from Rye pond was conducted by the Department of Water Supply, Gas and Electricity.

The disposal of excrementitious wastes by incineration was continued for all labor within the limits of watersheds, and was generally in force for the remainder of the work where improved sewerage was not available.

Substantially all of the labor force employed by contractors operating outside of the limits of The City of New York was as heretofore under the direct observation at all times of regularly appointed physicians. Weekly reports were received, and form the

basis of the table of vital statistics of labor employed, Table 28. Additional information was used wherever available in reasonably accurate form.

The health records of the Aqueduct Police and of the Engineering forces are, as heretofore, incomplete, and the previous practice of omitting them from the table of vital statistics has been followed for the year 1914.

CAMP STATISTICS

Total average population in camps	4,112
Total average population not in camps	2,988
Total average population under observation and treatment	7,100
Surgical cases	9,100
Medical cases	16,149
Cases of communicable diseases	86
Deaths	28

The designation "Surgical" and "Medical" cases should be interpreted as the total number of treatments, and not the number of persons treated, as more fully explained in the 1912 annual report, page 255.

EPIDEMIOLOGY

Smallpox was absent from the work.

Typhoid was generally absent from the work, there being only two definite cases. One of these was the wife of contractor's employee, living in the main camp, Contract 3, in a house where typhoid had quite frequently appeared in previous years. A somewhat extensive investigation was made to determine, if possible, the existence of a carrier in or adjacent to this building. This study included the examination of bloods from nine persons, without positive reactions in any case. The other identified case of typhoid occurred in Camp Kensico, Contract 9. This man was an employee of the contractor, who furnished no apparent cause of illness, except the previous use of water from shallow subsurface supplies in the midst of an Italian settlement adjacent to the camp.

Malaria was substantially absent from the work.

Other Infectious Diseases were not present in epidemic form, being as a rule scattered cases, less numerous than in previous years. Prompt examination, and the enforcement of quarantine or other precautions were effective in keeping these diseases under control.

Special Efforts were made, as heretofore, to have the contractors' physicians keep on hand at all times proper amounts of biological products for immunization and treatment of infectious diseases. Biological supplies, aggregating the following quantities, were distributed to the physicians on the various contracts, as called for by them: 20,000 units of diphtheria antitoxin; 2,450 points of vaccine virus; 85 doses of typhoid vaccine; one treatment of autogenous vaccine; 22 streptococcus and staphylococcus vaccine; 18 Widal outfits, and 6 culture tubes and swabs.

Samples and Specimens for Laboratory Diagnosis of suspected cases of communicable and infectious diseases were collected and reported on as follows:

Blood for Widal test	35
Urine and feces	7
Sputum	9
Swab	1
Autogenous culture	1

SANITARY AND MEDICAL SERVICES—BOARD'S FORCES

Engineering Bureau

Special supervision over the health and sanitary problems of the engineering forces was given in all cases where request was made.

Headquarters Department.—Immunization treatment was given to the members of the force in this department, as follows: Typhoid vaccine, 15 members, and smallpox vaccine, 3 members.

Reservoir Department.—Examinations were made in September and October of alleged persistent typhoid at Mt. Tremper, and all the facts were placed before the State Health Department, with a request for its action in the matter. Examinations were made in September and October of isolated cases of typhoid at Tongore and Bushkill, and of suspicious typhoid cases at the Beaver Kill Club house and at the old stone house on the railroad right-of-way near Glenford. Improvements were made in sanitary conditions in the Esopus watershed by the replacement or relocation of privies on private premises. Examination was made with respect to alleged increase of malaria adjacent to the East basin of the Ashokan reservoir, and attention was called to conditions of flooding, which might be expected to provide breeding places for anopholes. Examination was made of an epidemic of glanders occurring among

horses at West Hurley and Stone Church, as a result of which three horses were destroyed. Examination was also made of building on Parcel 615, and recommendation was made for its destruction for sanitary reasons.

Southern Aqueduct Department.—Further examination was made of suspicious carrier of typhoid or paratyphoid in family of one of the force, in the Kensico division, without obtaining positive diagnosis. Examinations were made in January and December of scarlet fever outbreaks in North White Plains and Valhalla, where the assistance of the local health authorities was sought in controlling these disturbances. An outbreak of suspicious typhoid in the village of Pleasantville in May was also investigated. Samples of the local water-supply were analyzed, and the assistance of the local health authorities was sought for further investigations connected with this trouble. Conferences were held with representatives of the Bronx Valley Parkway Commission with respect to alleged contamination of the Bronx river.

City Aqueduct Department.—Conferences were held with the officials of the Sailors' Snug Harbor on Staten Island, with respect to alleged contamination of water-supplies on its property. Report and recommendations were furnished.

Police Bureau

Garrison Detachment.—Examination was made of one of the employees for tuberculosis, and arrangements were made with the Department of Charities, New York City, to care for this man at the Sea View Hospital.

DRAWINGS, ILLUSTRATIONS AND TABLES

Various drawings, illustrations and tabulations, as referred to in the text, are transmitted herewith.

Respectfully submitted,

J. WALDO SMITH,

Chief Engineer

Schedule of Employees by Departments in Engineering Bureau in 1914

Civil Service Title	Headquarters		Reservoir		Northern Aqueduct		Southern Aqueduct		City Aqueduct		Total Number		Total Per Cent.	
	Jan. 1	Dec. 31	Jan. 1	Dec. 31	Jan. 1	Dec. 31	Jan. 1	Dec. 31	Jan. 1	Dec. 31	Jan. 1	Dec. 31	Jan. 1	Dec. 31
Chief Engineer	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Deputy Chief Engineer	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Consulting Engineers	4	3	..	..	..	..	..	..	..	..	4	3	..	..
Department Engineers	2	1	1	1	1	1	1	1	1	1	6	5	..	..
Division Engineers	1	1	1	..	2	1	5	4	4	2	13	8	..	..
Designing Engineers	2	2	..	..	..	..	..	..	..	..	2	2	..	..
Engineer Inspector	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Architect	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Mechanical Engineer	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Assistant Mechanical Engineer	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Electrical Engineer	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Assistant Engineers in Charge of Section	1	1	..	..	..	..	1	1	..	..	2	2	..	..
Assistant Engineers, Designer	9	10	..	..	..	..	..	..	..	..	9	10	..	..
Assistant Engineers	43	41	19	19	23	4	43	33	52	47	180	144	..	..
Architectural Designer	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Architectural Draftsmen	2	4	..	..	..	..	..	..	..	..	2	4	..	..
Structural Steel Draftsman	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Mechanical Draftsmen	2	2	..	..	..	..	..	..	..	..	2	2	..	..
Topographical Draftsmen	14	13	1	1	..	..	1	..	4	4	20	18	..	..
Draftsman's Helper	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Inspectors of Steel	3	2	..	..	..	..	..	..	..	..	3	2	..	..
Inspectors of Masonry	3	4	1	1	..	..	8	8	13	8	25	21	..	..
Inspectors, Regulating Grading and Paving	..	..	1	1	..	..	..	1	2	1	3	3	..	..
Inspector of Sewer Construction	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Inspector of Cement Tests	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Inspectors of Pipe Castings	1	3	..	..	..	..	..	..	..	..	1	3	..	..
Inspectors	7	6	7	7	2	2	18	16	46	30	80	61	..	..
Chemists	2	2	..	..	..	..	..	..	..	..	2	2	..	..
Photographers	2	2	..	..	..	..	..	..	..	..	2	2	..	..
Forester	..	..	..	..	..	..	1	1	..	..	1	1	..	..
Transitmen	1	..	10	6	4	2	7	3	7	7	29	18	..	..
Rodmen	2	..	9	10	10	7	18	17	29	24	68	58	..	..
Axemen	..	..	5	8	1	3	7	6	1	1	14	18	..	..
Chief Clerk	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Private Secretary	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Statistician	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Clerks	26	29	5	6	6	5	19	13	4	6	60	59	..	..

TABLE 1 (*Concluded*)

Civil Service Title	Headquarters Jan. 1	Headquarters Dec. 31	Reservoir Jan. 1	Reservoir Dec. 31	Northern Aqueduct Jan. 1	Northern Aqueduct Dec. 31	Southern Aqueduct Jan. 1	Southern Aqueduct Dec. 31	City Aqueduct Jan. 1	City Aqueduct Dec. 31	Total Number Jan. 1	Total Number Dec. 31	Total Per Cent. Jan. 1	Total Per Cent. Dec. 31
Cataloger	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Librarian	1	1	..	..	..	..	..	..	..	..	1	1	..	..
Stenographers	16	15	2	2	3	1	4	4	6	6	31	28	..	..
Typewriting Copyists	1	..	..	..	1	..	..	..	..	..	2	..	..	..
Telephone Operators	1	1	1	1	..	..	..	..	1	..	3	2	..	..
Automobile Engineman in Charge	..	..	..	..	..	..	1	1	..	..	1	1	..	..
Automobile Enginemen	..	..	1	2	3	2	2	1	3	3	9	8	..	..
Automobile Machinist	..	..	..	..	..	..	..	1	..	..	..	1	..	..
Locomobile Engineman	..	..	..	..	..	..	1	1	..	..	1	1	..	..
Chauffeur	..	..	1	1	..	..	..	..	..	..	1	1	..	..
Marine Engineman	..	..	..	..	1	1	..	..	..	..	1	1	..	..
Driller	..	..	1	1	..	..	..	..	..	..	1	1	..	..
Janitors	..	..	..	..	2	3	..	..	..	..	2	3	..	..
General Foreman	..	..	1	1	..	..	..	..	..	..	1	1	..	..
Foremen	..	..	..	1	1	5	..	2	..	..	1	8	..	..
Master Machinist	1	..	..	..	..	1	..	..	..	..	1	1	..	..
Machinists	..	..	..	..	..	3	..	..	..	..	..	3	..	..
Machinists' Helpers	..	..	..	..	..	7	..	..	..	..	..	7	..	..
Electricians	..	..	..	..	..	4	..	..	..	..	..	4	..	..
Hoist Operators	..	..	..	..	..	3	..	..	..	..	..	3	..	..
Store Keepers	1	..	1	1	..	..	..	..	..	..	2	1	..	..
Laborers	4	4	54	69	24	39	51	38	5	5	138	155	..	..
Cleaner	..	..	1	..	..	..	..	..	..	..	1	..	..	..
Gage Keepers	2	2	27	29	..	..	..	..	..	..	29	31	..	..
Totals	*170	*165	150	168	84	94	188	152	178	145	770	724	..	..
CLASSES														
Engineers—Assistant engineers and higher rank	70	67	22	20	26	6	50	39	57	50	225	182	29.2	25.1
Engineering Assistants—Draftsmen, rodmen and axemen	43	42	34	35	17	14	60	52	102	75	256	218	33.2	30.1
Clerks—Clerks, stenographers and miscellaneous	50	50	9	9	10	6	23	17	11	12	103	94	13.4	13.0
Labor Class	5	4	58	75	31	68	55	44	8	8	157	199	20.4	27.5
Gage Keepers	2	2	27	29	..	..	..	..	..	..	29	31	3.8	4.3
Totals	*170	*165	150	168	84	94	188	152	178	145	770	724	100.0	100.0

* Including Chief Engineer and 1 Deputy Chief Engineer, 4 Consulting Engineers to April 22, and 3 Consulting Engineers thereafter, 1 Department Engineer to July 31, 2 Assistant Engineers, 1 Private Secretary and 1 Stenographer on staff of Chief Engineer; also 2 Gage Keepers in Long Island [illegible]

TABLE 2

Leases Entered Into for Engineering Bureau During 1914

Lease	Location of Premises	Description of Premises	Lessor	Date of Lease 1914	Date of Expiration	Quarterly Rental	Occupant Department Division
186	Cornwall-on-Hudson, N. Y..	Second floor of Cornwall Savings Bank Building	Cornwall Savings Bank....	Apr. 22	May 1, 1915	$60.00	Northern Aqueduct Executive
187	New Paltz, N. Y...........	Two rooms in Hasbrouck building....	Howard Hasbrouck........	Apr. 1	Dec. 31, 1914	24.00	Northern Aqueduct Wallkill
*188	293 Wall St., Kingston, N. Y.	Two rooms	Matilda L. Cordts.........	Apr. 21	May 1, 1915	114.00	Reservoir
*189	Mt. Pleasant, N. Y.........	2-story frame building 28 feet by 37 feet, barn in rear and plot of ground	Bryant Park Realty Company	May 1	Monthly	150.00	Southern Aqueduct White Plains
*190	Railroad Ave., White Plains, N. Y.............	Fourth floor (except seven rooms), vault, blue-print structure on roof and room in basement of Realty building	White Plains Realty Company	Oct. 21	Dec. 1, 1915	225.00	Southern Aqueduct Executive
192	Cornwall-on-Hudson, N. Y..	One room in Matthiessen building....	Village of Cornwall, N. Y..	Oct. 28	Jun. 1, 1915	37.50	Northern Aqueduct Executive
**193	....	....	Central Hudson Gas & Electric Company........	Oct. 17	Dec. 15, 1915	....	....
195	Prattsville, N. Y...........	Two rooms	Thomas J. O'Hara.........	Dec. 1	Dec. 1, 1915	36.00	Reservoir

*Renewals

**For furnishing electric generating and transmitting apparatus and lines to supply electrical energy at Shaft 7 of the Moodna pressure tunnel at the rate of $1,835 per month and for electrical energy necessary for unwatering tunnel at the rate of 1½ cents per kilowatt-hour

TABLE 3

Rainfall in Inches

Watershed and Station	1914 Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	1914 Total	1913 Total	1912 Total	1911 Total	1910 Total	1909 Total	1908 Total	1907 Total	1906 Total
CATSKILL MOUNTAIN WATERSHEDS																					
Esopus																					
Phoenicia ....*	3.17	3.02	5.04	6.03	3.00	2.48	4.10	3.95	0.62	2.71	4.54	3.60	42.26	50.21	50.43	41.04	48.56	45.93	45.13	46.78	44.52
Slide Mountain ...**	4.26	2.81	3.98	5.48	2.72	4.27	2.97	4.18	1.14	2.84	3.64	6.43	44.72	58.10	61.85	48.97	57.82	54.62	50.87	53.45	58.72
Highmount ....**	2.64	2.20	4.66	5.84	3.50	4.14	2.87	4.03	1.04	2.61	2.46	3.16	39.15	39.47	45.07	37.27	40.32	35.55	34.72	41.56	42.82
Edgewood ....**	3.62	2.28	3.58	6.99	2.99	3.05	4.69	3.68	0.61	2.77	3.88	2.99	41.13	50.36	53.13	40.56	48.64	46.43	46.98	52.90	47.85
Lake Hill ....**	3.46	2.04	2.90	6.16	3.52	3.19	3.09	3.56	0.38	2.65	3.39	3.59	37.93	46.76	47.86	42.65	46.71	50.23	46.52	49.25	46.30
Overlook Mountain.**	3.71	2.68	3.46	5.90	2.83	2.86	3.58	3.78	0.32	3.33	3.09	3.26	38.80	46.12	46.77	41.52	49.18	54.82	46.37	....	....
Kingston ....**	3.50	1.99	4.46	4.84	3.36	3.88	3.80	3.23	0.66	3.04	2.69	2.18	37.63	40.31	41.84	42.43	40.98	41.85	37.18	42.85	....
West Hurley .....**	2.83	2.37	3.98	5.42	2.75	2.50	4.05	2.82	0.37	2.88	2.83	2.74	35.54	42.87	46.81	40.07	43.85	46.67	42.05	47.40	....
Brown's Station..***	2.96	2.22	4.41	5.85	2.96	3.32	3.47	3.62	0.31	3.57	3.22	3.04	38.95	46.73	46.57	45.38	45.23	48.79	42.01	47.01	....
Ashokan ....†	3.66	2.48	4.29	5.57	2.96	2.20	3.12	3.62	0.35	3.55	3.12	3.34	38.26	46.28	49.98	45.96	51.30	51.76	44.13	50.59	47.91
Moonhaw Lodge..§**	3.64	2.32	3.93	6.16	2.64	3.80	2.98	5.88	0.42	2.78	2.98	4.71	42.24	61.86	60.90	56.49	58.63	62.31	54.80	....	....
High Point ....**	....	....	....	....	....	....	....	....	....	....	3.13	3.34	....	....	....	....	....	....	....	....	....
Rondout																					
Grahamsville .....**	3.74	2.01	3.60	5.08	3.24	4.66	4.16	4.57	1.05	2.86	2.66	3.63	41.26	50.34	45.36	46.55	42.46	44.10	41.73	43.24	44.68
Sundown ....*	2.80	2.18	3.31	4.34	1.77	3.34	2.70	4.00	0.71	1.55	2.71	3.26	32.67	49.20	40.71	42.69	45.25	43.61	40.52	47.07	46.96
Peekamoose ......**	3.76	2.55	3.44	4.42	3.55	4.65	3.95	4.06	0.43	3.47	3.38	6.09	43.75	61.62	61.08	57.19	57.71	56.06	58.71	....	....
Lackawack .....‡**	2.85	1.94	3.62	5.06	3.69	4.42	5.30	2.58	0.32	3.14	2.49	3.00	38.41	48.44	41.68	41.89	43.75	39.35	39.19	44.45	42.55
Claryville ....**	3.48	1.98	3.88	5.64	2.64	4.34	4.21	5.48	1.06	2.17	2.44	3.10	40.42	52.79	48.31	46.12	47.09	44.16	44.27	50.23	....
High Falls ....**	2.42	3.20	4.51	5.30	3.67	2.66	3.42	2.84	0.26	3.74	2.88	2.80	37.70	38.58	36.75	43.79	39.35	42.77	38.93	....	....
Schoharie																					
Windham ....**	2.56	2.20	4.96	4.93	3.24	3.26	4.15	4.90	0.88	1.64	2.15	3.18	38.05	35.32	35.39	28.86	41.14	36.68	36.26	37.98	....
Haines Falls .....**	2.40	2.19	3.74	5.97	3.05	2.36	3.89	4.57	0.40	2.61	4.48	2.56	38.22	42.52	40.85	38.38	48.19	47.32	48.51	52.64	....
Lexington ....**	2.08	2.35	4.49	4.70	3.12	2.86	4.28	5.20	1.00	1.78	2.34	2.44	36.64	44.01	38.85	30.14	38.72	37.41	32.47	36.94	....
Prattsville ....**	2.08	2.36	4.84	5.27	3.66	3.38	4.57	4.18	1.19	1.70	1.90	2.32	37.45	33.80	33.37	30.44	37.01	32.07	28.25	....	....
Catskill																					
Preston Hollow...**	1.68	2.08	4.76	5.18	3.36	2.42	4.22	3.30	0.63	1.34	2.44	2.15	33.56	35.96	33.46	32.41	31.78	34.16	30.81	34.41	....
Oak Hill ....‡‡**	1.90	2.18	4.81	5.02	3.86	2.02	3.56	3.76	0.48	1.62	3.13	3.09	35.43	34.91	35.99	32.92	33.73	35.38	31.97	36.68	....
Franklinton ......**	2.12	2.27	5.08	6.01	2.62	2.56	4.12	4.36	0.76	1.50	2.07	1.98	35.45	35.66	30.95	28.91	31.59	31.49	28.27	37.68	....
Westerlo ....**	2.24	1.96	4.30	5.48	3.24	2.22	3.78	4.60	0.47	1.54	2.65	1.74	34.22	32.35	39.08	30.30	31.02	33.11	31.53	35.28	....
WATERSHEDS WEST OF HUDSON RIVER (OTHER THAN CATSKILL MOUNTAIN)																					
Wallkill																					
New Paltz ....**	2.86	2.90	4.33	4.86	3.04	3.16	3.96	3.22	0.16	3.31	2.46	3.16	37.42	43.00	40.27	42.12	40.73	40.00	40.74	46.50	....
Walden ....**	....	....	....	+2.11	2.21	2.33	1.98	2.21	0.44	3.04	2.65	2.06	....	....	35.29	35.86	40.21	30.20	29.14	....	....
Moodna																					
Cornwall ....**	2.72	2.37	5.83	2.80	2.40	3.18	4.30	1.78	0.35	2.90	5.16	4.38	38.23	44.40	30.74	44.81	42.77	41.57	37.00	51.02	....

Watershed and Station	1914 Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	1914 Total	1913 Total	1912 Total	1911 Total	1910 Total	1909 Total	1908 Total	1907 Total	1906 Total
WATERSHEDS EAST OF HUDSON RIVER (OTHER THAN CROTON AND BRONX)																					
Roeliff Jansen																					
Silvernails ....**	2.34	1.55	6.45	5.19	2.30	2.61	3.95	4.04	0.66	2.72	2.16	2.18	36.15	36.11	41.70	41.50	35.70	36.33	30.64	....	....
Wappinger																					
Pleasant Valley....**	2.82	2.18	3.69	4.96	3.42	2.51	3.90	2.99	0.28	3.32	2.73	3.40	36.20	42.58	39.11	47.95	41.82	38.49	33.55	....	....
Peekskill																					
Cold Spring ....§§**	....	....	6.37	4.74	3.01	2.90	5.37	2.19	0.32	2.90	3.83	4.42	....	48.91	48.17	46.37	39.56	42.63	39.89	49.45	....
Peekskill ....**	3.75	1.88	2.97	4.76	3.53	3.26	6.18	2.42	0.38	3.45	3.64	4.45	40.67	50.01	43.41	46.39	40.07	43.09	43.66	....	....
CROTON WATERSHED																					
Boyd's Corners....††	3.59	2.33	4.33	5.15	3.26	3.40	4.99	2.50	0.33	3.96	3.64	4.26	41.74	51.17	50.29	52.89	42.15	51.55	40.11	56.19	48.67
Old Croton Dam...††	4.10	1.98	4.22	4.33	3.15	3.13	4.78	1.73	0.21	2.97	4.12	4.83	39.55	49.15	45.43	46.14	44.70	51.05	48.66	61.17	48.06
Middle Branch.....††	3.99	2.22	4.62	4.31	2.63	3.04	5.29	2.56	0.40	3.56	2.82	3.94	39.38	46.89	44.53	51.72	45.14	51.55	41.92	59.86	46.54
Carmel Reservoir..††	3.92	1.97	4.15	4.91	2.78	3.40	4.68	2.29	0.25	4.11	2.82	3.31	38.59	49.61	48.13	50.07	44.91	51.91	39.07	57.94	50.62
East Branch ......††	3.90	2.12	4.83	4.41	2.81	2.70	5.15	2.44	0.35	3.26	2.96	4.27	39.20	47.71	43.86	45.25	42.01	50.09	38.80	56.41	44.00
Amawalk ....††	4.20	2.23	4.75	4.40	2.85	3.47	4.84	2.08	0.18	2.99	3.31	3.91	39.21	50.36	43.98	48.13	41.89	48.15	45.06	57.59	47.00
Titicus ....††	3.96	3.02	4.66	4.00	2.88	2.90	5.17	2.02	0.37	3.23	3.49	4.41	40.11	49.79	43.78	46.92	41.24	56.58	47.41	65.07	52.81
Katonah ....††	3.78	2.48	4.23	4.33	3.23	3.67	4.90	1.59	0.36	2.78	4.00	4.30	39.65	52.21	46.00	46.90	41.60	47.98	43.23	54.14	47.70
Croton Falls ......††	3.38	3.07	4.49	3.92	2.51	2.83	5.46	1.81	0.40	2.96	2.89	3.79	37.51	47.35	44.38	44.48	39.73	46.90	36.01	....	....
BRONX WATERSHED																					
Kensico ....††	4.76	1.37	3.51	3.73	3.07	2.05	5.80	1.62	0.30	3.21	3.00	5.45	37.87	50.56	46.98	50.11	43.97	52.70	53.28	58.30	50.35
SUFFOLK COUNTY WATERSHED																					
Babylon ....†††	5.05	2.89	4.91	3.91	2.61	3.35	4.44	2.11	0.13	2.72	2.12	5.76	40.00	45.45	46.78	51.06	41.39	37.44	32.54	42.06	....
Ronkonkoma .....†††	5.64	3.80	4.65	4.53	3.19	2.27	3.31	2.55	0.33	3.50	2.54	6.34	42.65	50.85	51.63	55.40	40.37	42.93	32.71	....	....

* New England Water Works Association Badger make weighing gage
** Friez standard 8-inch gage
*** Friez 12-inch automatic tipping-bucket gage and Fries standard 8-inch gage until July 1, 1913; latter gage only, thereafter
† Friez standard 8-inch gage; also Friez 12-inch automatic tipping-bucket gage after July 1, 1913. Records prior to July 1, 1913 are for West Shokan
†† Records of Department of Water Supply, Gas and Electricity
††† Standard 8-inch Weather Bureau gage

‡ Records for 1909 and prior are for Napanoch station, which was superseded by Lackawack
‡‡ Records for 1909 and prior are for East Durham station, which was superseded by Oak Hill
§ Rain-gage removed from Maltby hollow (Elevation 915) to Watson Hollow (Elevation 1,000) two miles distant, November 30, 1913
§§ Records for this station were kept at Garrison during 1912 and 1913
\+ Four days missing

TABLE 4

Stream Flow—Catskill Mountain Watersheds

Mean Monthly Discharge in Cubic Feet per Second

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	The Year
§ESOPUS CREEK AT ESOPUS WEIR—DRAINAGE AREA 239 SQUARE MILES													
1906.....	....	....	....	....	....	....	....	....	....	*363	426	359	....
1907.....	743	202	633	543	594	416	90	30	423	847	1,439	1,116	590
1908.....	642	803	1,140	961	1,567	242	136	56	36	176	191	203	513
1909.....	811	1,539	820	1,279	838	388	78	106	57	56	42	158	514
1910.....	1,077	606	1,704	1,958	460	407	92	65	101	48	146	92	563
1911.....	579	349	548	1,000	336	504	130	88	159	909	578	527	476
1912.....	327	460	1,494	1,737	819	188	77	232	155	352	576	705	594
1913.....	1,155	277	1,485	768	462	231	41	44	95	701	1,401	498	596
ESOPUS CREEK AT COLD BROOK—DRAINAGE AREA 192 SQUARE MILES													
1914.....	195	389	843	2,008	643	112	91	77	45	32	106	199	393
§ESOPUS CREEK AT MT. MARION—§§DRAINAGE AREA 368 SQUARE MILES													
1907.....	....	....	....	**836	953	652	162	50	859	1,352	2,177	1,681	....
1908.....	1,240	1,323	2,157	1,406	2,392	401	242	99	43	223	243	239	834
1909.....	1,247	2,824	1,527	1,757	1,278	661	138	168	99	100	83	316	850
1910.....	1,608	678	3,029	3,356	791	761	147	105	133	76	204	146	920
1911.....	784	544	952	1,504	406	818	192	152	268	1,506	936	824	740
1912.....	496	719	2,360	2,383	1,181	305	94	258	191	522	916	1,022	871
1913.....	1,833	511	2,787	1,378	803	373	101	98	+68	837	1,978	898	972
§RONDOUT CREEK AT HONK FALLS—DRAINAGE AREA 102 SQUARE MILES													
1906.....	....	†184	310	601	202	198	128	73	37	85	93	102	....
1907.....	251	252	359	172	172	119	23	19	149	279	479	380	221
1908.....	260	322	516	468	459	84	39	30	14	31	38	72	194
1909.....	383	680	335	372	347	140	47	26	27	27	28	58	206
1910.....	354	258	725	623	....	....	....	....	....	....	....	....	....
§RONDOUT CREEK AT LACKAWACK—DRAINAGE AREA 100 SQUARE MILES													
1910.....	....	....	....	....	246	142	39	38	70	34	91	154	....
1911.....	251	210	304	484	128	204	51	39	79	387	276	273	224
1912.....	273	333	616	555	288	97	40	108	76	126	190	282	249
1913.....	522	208	691	394	209	105	42	65	76	266	517	224	277
1914.....	166	196	532	831	316	87	75	51	27	35	54	140	209

TABLE 4 (*Concluded*)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	The Year
§SCHOHARIE CREEK AT PRATTSVILLE—DRAINAGE AREA 236 SQUARE MILES													
1907.....	‡485	‡160	‡648	‡605	510	352	114	22	255	778	1,333	1,238	542
1908.....	429	763	992	720	957	145	75	33	17	129	100	194	380
1909.....	628	1,220	771	1,045	674	291	51	37	27	30	28	91	408
1910.....	796	802	1,312	1,394	376	399	80	49	56	53	311	337	497
1911.....	649	204	578	1,063	286	481	41	34	142	614	365	600	422
1912.....	270	517	1,410	1,573	592	137	42	94	84	315	376	594	500
1913.....	1,057	241	1,402	675	347	150	33	34	88	507	1,200	439	514
1914.....	319	488	1,120	2,351	814	52	57	60	24	24	129	200	468
CATSKILL CREEK AT OAK HILL—DRAINAGE AREA 97 SQUARE MILES													
1910.....	....	....	....	....	81	156	11	6	7	8	42	35	....
1911.....	97	83	121	224	52	206	5	2	5	57	75	105	86
1912.....	46	90	378	456	153	38	6	8	12	59	123	157	127
1913.....	360	124	469	191	83	27	3	2	2	38	293	16	184
1914.....	70	114	574	937	321	9	14	7	3	2	5	8	172

* 13 days' record ** 27 days' record † 16 days' record
‡ From United States Geological Survey record
+ Conduit of Olive Bridge dam was closed September 9, 1913; from this date flow was influenced by storage and waste
§ A re-determination of drainage areas has been made, based on the United States Geological Survey quadrangles, some of which were not available when the original areas were determined. These new areas were made effective January 1, 1913. The following is a comparison with previous published values:

Creek and Station	Areas Used to December 31, 1912 Square Miles	Areas Used 1913 and After Square Miles
Esopus creek at Esopus weir..	239	239
Esopus creek at Mt. Marion..	378	§§368
Rondout creek at Honk Falls..	105	102
Rondout creek at Lackawack..	104	100
Schoharie creek at Prattsville	240	236

§§ The drainage area of the Esopus creek at Mt. Marion does not include the Sawkill diversion for the Kingston water-supply (33 square miles), nor Plattekill diversion for Saugerties water-supply (17 square miles). Total drainage area above Mt. Marion is 418 square miles

TABLE 5

* Contracts Prepared or in Preparation During 1914

Contract	Description of Work	Advertising Commenced 1914	Bids Opened 1914	Date of Award 1914	Amount of Contract
76	Ashokan bridge	May 27	Jun. 23	Jun. 30	$114,535.00
86	Part of Queens conduit	Mar. 26	Apr. 14	Apr. 28	298,908.15
88	Part of Richmond conduit	Apr. 23	May 12	May 19	70,186.60
104	Gate-valves, controlling valves, flap valves, pressure-regulating valves, sluice-gates and appurtenances for City aqueduct and Croton Lake siphon	Jan. 15	Feb. 3	Feb. 10	88,600.00
118	Eleven superstructures for Sprout Brook, Peekskill, Hunters Brook, Turkey Mountain and Harlem Railroad siphon chambers and Croton Gaging chamber	Apr. 2	Apr. 21	Apr. 28	110,375.00
120	Hudson Drainage Chamber and Croton Downtake Chamber superstructures	....	....	....	....
123	Six superstructures for Kensico Influent, Upper and Lower Effluent and Screen chambers and Kensico siphon chambers	....	....	....	....
124	Nine superstructures for Ashokan Upper and Lower Gate, Screen and Gaging chambers and Esopus and Tongore siphon chambers, and balustrades and cartouches on Ashokan bridge	Apr. 29	Jun. 2	Jun. 16	345,535.00
125	Ashokan superintendent's buildings	....	....	....	....
127	Kensico superintendent's buildings	....	....	....	....
128	Hill View Uptake and Downtake Chamber superstructures	....	....	....	....
129	Morningside Park and East River Drainage Chamber superstructures	....	....	....	....
143	Fences on roads below Beaver Kill dikes	....	....	....	....
145	Roofing, with reinforced concrete tiles, various superstructures along the line of Catskill aqueduct	Jun. 18	Jul. 14	Jul. 23	110,947.00
147	Riser-valve controlling apparatus	....	....	....	....
148	Portion of Catskill Aqueduct telephone system	May 22	Jun. 9	Jun. 23	16,155.60
154	Cast-iron gate-valves for operating mechanisms, City tunnel	....	....	....	....
156	Tree transplants at Ashokan and Kensico reservoirs	Mar. 18	Apr. 3	Apr. 7	26,000.00
158	Filling expansion joints, Olive Bridge dam	....	....	....	....
159	Plant for removal of color and turbidity	....	....	....	....
160	Moodna Siphon supplementary shaft and tunnel	Oct. 21	Nov. 10	Nov. 12	365,926.00
161	Motors, drives and wiring for gang drives, Ashokan reservoir	....	....	....	....
162	About 8,000 square feet of face cutting of stones for Kensico dam	Dec. 31	....	....	....
163	Excavation for and laying pipe and special felting for operating mechanisms for riser valves of City tunnel	....	....	....	....
AF	General printing for 1915 and 1916	Nov. 19	Dec. 8	Dec. 15	16,942.10

* All contracts prepared by Headquarters department

TABLE 6

Contracts Completed Prior to January 1, 1913

Contract	Description of Work	Contractor	Date of Completion	Amount of Contract	Final Estimate
1	Test-borings in and along shores of Hudson river near New Hamburg and Storm King	*The Phoenix Construction Company	Dec. 31, 1910	†$195,000 00	$125,320.88
4	Field office building for division and section engineers in Peekskill division	Daniel Çarpenter	May 1, 1908	11,095 00	11,095 00
5	Portion of an intercepting sewer in the City of Kingston	Haggerty Contracting Company	Jun. 12, 1908	14,568 35	13,653 22
6	Field office building for division and section engineers in Esopus division	John J. McLean	Mar. 3, 1909	8,965.00	8,965.00
7	Field office building for division and section engineers in Kensico division	Shelley Bros	Nov. 5, 1909	8,360.00	8,360.00
11	Esopus cut-and-cover and Peak grade tunnel in Esopus division	**H. S. Kerbaugh, Incorporated	Jul. 29, 1912	2,368,920.00	2,279,324.04
16	St. Elmo cut-and cover in Newburg division	***King, Rice & Ganey Company	May 21, 1912	610,407 50	578,624 77
22	Bull Hill grade tunnel and cut-and-cover in Hudson River division	Patterson & Company; Receivers, James G. Shaw and Benjamin Barker	Sep. 7, 1912	824,942.50	724,642 97
25	Croton and Chadeayne grade tunnels and cut-and-cover in Croton division	Chas. W. Blakeslee & Sons	Dec. 23, 1912	††1,289,830.00	1,284,450.70
34	Water-mains at Jerome Avenue pumping-station	Fox-Hennessy Co	Sep. 11, 1912	26,859.00	26,654.52
38	Borings along City tunnel	The Snare and Triest Co	Aug. 29, 1910	105,678.00	92,198.32
39	Pumping-plant at Jerome Avenue pumping-station	Lord Electric Co	Apr. 17, 1912	34,884.00	34,384.00
40	Three field office buildings, three horse-sheds and a stable in Esopus division	John J. Wilson	Nov. 30, 1909	11,859.00	11,859.00
48	Portion of an intercepting sewer in the City of Kingston	King, Rice & Ganey Company	Jun. 1, 1912	†††172,000 00	171,776.25
50	Three field office buildings and two horse-sheds and moving one horse-shed in Croton division	Joseph A. Dassler	May 16, 1910	11,868.00	11,868.00
59	Constructing highways around Ashokan reservoir	The C. P. Bower Construction Company	Dec. 7, 1912	323,861.00	306,193.60
73	Borings along City tunnel	Sprague & Henwood	‡Jul. 31, 1910	46,650.00	58,665.96
74	Field office building and horse-shed in White Plains division	Joseph A. Dassler	Sep. 29, 1910	8,065.00	8,065.00
77	Wakefield Avenue blow-off from Hill View reservoir	Geo. L. Brown and T. J. Brown	Nov. 12, 1912	58,178.25	53,352 63
80	Breakneck pressure and grade tunnels in Hudson River division	The Dravo Contracting Company	Nov. 11, 1912	456,515.00	398,353.41
81	Four field office buildings and five horse-sheds in Croton, White Plains and Hill View divisions	John F. Hickey	Jan. 19, 1911	18,402.00	18,402.00
83	Furnishing and erecting telephone poles and appurtenances along Catskill aqueduct	Carpenter & Lindsay	Dec. 31, 1910	10,402.50	11,256.49
98	Borings along City tunnel	The Healey Sewer Machine and Construction Company	Dec. 31, 1910	39,175.00	21,078.01
100	Extension of Croton blow-off into Croton lake	Stobaugh Contracting Company	Aug. 23 1912	‡‡46,072.50	44,677.24
113	Test-pits and borings on the site of Silver Lake reservoir	Sweeney & Gray Company	Apr. 20, 1912	‡‡‡5,500.00	4,933.28
132	Borings at site of Silver Lake reservoir	Healey Contracting Company	Aug. 14, 1912	§3,769.85	3,769.85
	Totals			$6,711,827.45	$6,311,924.14

TABLE 6 (*Concluded*)

Contract	Description of Work	Contractor	Date of Completion	Amount of Contract	Final Estimate
A	Printing 1906 annual report	The J. W. Pratt Company	Oct. 14, 1908	$1,689.84	$1,713.52
B	Class A—Engineering supplies and instruments	Technical Supply Co.	Apr. 5, 1910	3,804.09	3,995.34
B	Class B—Stationery supplies	The J. W. Pratt Company	Jan. 30, 1909	1,789.18	1,697.38
B	Class C—Printed forms	Continental Playing Card Company	Mar. 15, 1909	1,876.05	1,956.50
B	Class D—Hardware	Joseph N. Early	Apr. 1, 1909	3,710.51	3,617.50
C	Horses for patrolmen on aqueduct	Fiss, Doerr & Carroll Horse Company	Jun. 26, 1909	8,187.50	8,187.50
D	Printing 1907 annual report	Goldman & Steinberg Printing and Publishing Co.	Dec. 15, 1909	1,862.50	1,668.74
E	General printing for 1909	The J. W. Pratt Company	Sep. 5, 1910	12,815.11	7,982.67
G	Class 1—8,000 tons of bituminous coal	Parrish, Phillips & Company	May 13, 1910	23,120.00	23,379.58
G	Class 2—80 tons of Cumberland coal	George D. Harris & Company	Jul. 5, 1909	312.00	319.49
H	Class M—Boilers	Erie City Iron Works	Jun. 11, 1909	3,374.00	3,374.00
I	Class D—Lead seals	E. J. Brooks & Company	Apr. 1, 1910	2,652.50	2,518.50
J	Class A—Sunflower instruments	Keuffel & Esser Co.	Nov. 13, 1909	2,376.00	2,376.00
J	Class K—Lumber	Arthur C. Jacobson & Sons	Jan. 13, 1910	10,517.51	10,585.06
J	Class L—Millwork	H. W. Palen's Sons	Nov. 20, 1909	536.81	536.81
K	Class F—Oils	Alden S. Swan & Company	Nov. 27, 1909	1,727.00	1,798.28
N	Class 1—Furniture	Alexander Pearson	Aug. 20, 1910	3,654.50	3,701.46
N	Class 2—Furniture	John Wanamaker, New York	Aug. 20, 1910	1,514.97	1,588.19
O	Horses for patrolmen on aqueduct	Fiss, Doerr & Carroll Horse Company	Jan. 11, 1910	8,437.50	8,437.50
P	Class F—Oils	Alden S. Swan & Company	Feb. 28, 1911	1,956.00	1,970.79
Q	General printing for 1910	The Martin B. Brown Company	Apr. 5, 1911	8,880.86	6,897.59
R	Class 1—15,000 tons of bituminous coal	George D. Harris & Company	§§Aug. 15, 1911	43,950.00	43,753.14
R	Class 2—120 tons of Cumberland coal			486.00	480.39
T	Horses for patrolmen on aqueduct	Fiss, Doerr & Carroll Horse Company	Sep. 26, 1911	32,500.00	32,500.00
U	Class M—Boilers	Godfrey, Keeler Co.	Jun. 22, 1910	5,380.00	5,380.00
V	Class K—Lumber	Arthur C. Jacobson & Sons	Nov. 30, 1910	4,968.50	5,058.09
W	Printing minutes of Board for 1910	Clarence S. Nathan	Jan. 5, 1912	1,935.00	1,843.88
X	General printing for 1911	Brooklyn Daily Eagle	Jul. 5, 1912	14,413.49	9,036.90
Y	Class D—Miscellaneous hardware	Hammacher, Schlemmer & Co.	Jun. 13, 1912	1,566.69	1,297.05
Y	Class O—Engineering supplies	Keuffel & Esser Co.	Jun. 28, 1912	3,553.93	3,598.74
Z	Class B—Stationery supplies	Tower Manufacturing and Novelty Company	Aug. 30, 1912	3,468.85	3,629.25
AB	Horses for patrolmen on aqueduct	Fiss, Doerr & Carroll Horse Company	Jun. 15, 1912	8,937.50	8,937.50
	Totals			225,954.39	213,817.34
	Grand totals			$6,937,781.84	$6,525,741.48

*By assignment from American Diamond Rock Drill Company, February 21, 1908

**By assignment from Henry S. Kerbaugh, April 13, 1911, assignee of Stewart-Kerbaugh-Shanley Co., original contractors, by assignment March 7, 1911

***By assignment from King, Rice & Ganey, May 19, 1910

†Includes $90,225.00 additional, certified to be expended June 14, 1907, and $25,000.00 additional, certified to be expended June 30, 1908

††Includes $20,000.00 additional, certified to be expended December 17, 1912

†††Includes $25,300.00 additional, certified to be expended November 13, 1911

‡Work ordered terminated by Board July 20, 1910

‡‡Includes $4,500.00 additional, certified to be expended August 8, 1912

‡‡‡Includes $755.00 additional, certified to be expended April 19, 1912

§Includes $101.35 additional, certified to be expended August 26, 1912

§§November 11, 1911 fixed as date of acceptance of supplies

Contracts Completed During 1913

Contract	Description of Work	Contractor	Date of Completion 1913	Amount of Contract	Final Estimate
12	Rondout pressure tunnel, half Bonticou grade tunnel and cut-and-cover in Esopus division	The T. A. Gillespie Company	Nov. 28	$6,290,803.50	$6,286,577.34
15	Wallkill south cut-and-cover in Wallkill division	The Elmore & Hamilton Contracting Co.; *Receivers, Augustus N. Hand and Stephen L. Selden	Jul. 30	933,867.50	845,634.11
17	St. Elmo siphon and cut-and-cover in Newburg division	American Pipe and Construction Co.	Jul. 14	722,510.00	655,530.60
18	Portion of Orange cut-and-cover in Newburg division	American Pipe and Construction Co.	Jul. 14	836,185.00	756,944.80
20	Moodna pressure tunnel in Hudson River division	Mason & Hanger Company	Jul. 17	3,492,511.00	3,208,584.74
23	Hunters Brook and Scribner grade tunnels and cut-and-cover in Croton division	Glyndon Contracting Co.	Nov. 21	§1,111,916.71	1,111,916.71
24	Croton Lake pressure tunnel, Turkey Mountain grade tunnel and cut-and-cover in Croton division	Bradley Contracting Co.	Jun. 24	973,694.50	862,067.85
45	Portion of Orange cut-and-cover in Newburg division	Pittsburg Contracting Company	Oct. 23	1,675,290.00	1,522,893.34
47	Wallkill pressure tunnel, Mohonk and half Bonticou grade tunnels and cut-and-cover in Wallkill division	The Degnon Contracting Company	Oct. 17	4,982,726.00	4,682,557.88
49	Six reinforced concrete bridges and approaches, West basin, Ashokan reservoir	+The Harrison and Burton Company	Dec. 5	248,222.50	246,363.20
52	Eastview and Elmsford grade tunnels and cut-and-cover in White Plains division	Pittsburg Contracting Company	Dec. 26	2,205,852.50	2,025,199.40
58	Drainage equipment at Shaft 5 of Rondout pressure tunnel	§§D'Olier Centrifugal Pump & Machine Co.	Dec. 1	§§§61,185.00	60,664.00
61	Wallkill blow-off	**The Harrison and Boice Company	***Dec. 5	182,153.00	166,500.14
62	Seven steel-pipe siphons in Northern Aqueduct department	†The Snare & Triest Co.	††Oct. 31	1,643,365.00	1,601,467.55
68	Seven steel-pipe siphons in Southern Aqueduct department	†††The T. A. Gillespie Company	Oct. 21	1,189,557.50	1,182,513.81
93	Portion of Catskill Aqueduct Telephone System	New York Telephone Company	Dec. 26	‡41,617.65	51,526.31
101	Fences along Catskill aqueduct {District 2	The Degnon Contracting Company	{Dec. 13	21,713.75	17,208.53
	{District 3		{Dec. 22	32,181.50	25,755.57
109	Five superstructures for Foundry Brook and Indian Brook siphon chambers and Breakneck gaging chamber	A. L. Guidone and Company	Dec. 31	80,062.00	80,185.29
114	Pressure-regulating valves for City tunnel and pipe-lines	Coffin Valve Company	Mar. 1	13,405.00	13,405.00
	Totals			$26,738,819.61	$25,403,496.17
AA	General printing for 1912	M. B. Brown Printing & Binding Co	Sep. 5	21,810.45	15,373.69
	Grand totals			$26,760,630.06	$25,418,869.86

*Appointed permanent receivers March 29, 1911, in place of Albany Trust Co. and James M. Hamilton, appointed temporary receivers January 23, 1911

**By assignment from Harrison and Boice, July 26, 1912; portion assigned to Century Contracting Company, May 25, 1912

***Unassigned portion completed November 15, 1913

+By assignment from Harrison and Burton, June 20, 1912

§Includes $2,814.21 additional, certified to be expended December 22, 1913

§§By assignment from D'Olier Engineering Company, December 31, 1912

§§§Includes $6,000 additional, certified to be expended December 17, 1912; $1,500 additional, certified to be expended July 19, 1913, and $7,000 additional, certified to be expended October 8, 1913

†Portion assigned to Steel & Masonry Contracting Company, June 24, 1913

††Unassigned portion completed June 4, 1913

†††By assignment from David Peoples, August 19, 1910; portion assigned to Pittsburg Contracting Company

‡ Does not include $9,908.66 additional, certified to be expended March 31, 1914

TABLE 8

Contracts Completed During 1914

Contract	Description of Work	Contractor	Date of Completion 1914	Amount of Contract	Final Estimate
2	Mekeel, Garrison and Cat Hill tunnels and cut-and-cover in Peekskill division	Thomas McNally Company; Receiver, Benjamin B. Odell, Jr.	Aug. 31	$4,126,423.00	$3,988,342.28
31	Furnishing and installing four controlling valves for Ashokan reservoir	Ogden Iron and Steel Manufacturing Company	Dec. 23	54,900.00	54,900.00
53	Platt Avenue siphon and cut-and-cover in White Plains division	The Elmore & Hamilton Contracting Company; Receivers, Augustus N. Hand and Stephen L. Selden	Aug. 25	*1,535,150.00	1,513,319.57
55	Portion of Catskill aqueduct in Croton and Kensico divisions and works at Kensico reservoir	Rinehart & Dennis Co.	Oct. 1	4,545,487.50	4,370,363.90
60	Hurley dikes at Ashokan reservoir	MacArthur Brothers Company	Oct. 31	971,275.00	806,898.70
72	Clearing and grubbing Ashokan reservoir	J. F. Cogan Company, Contractors	Oct. 24	451,000.00	383,472.90
84	Furnishing bronze shaft caps for City tunnel	American Manganese Bronze Company	Sep. 25	90,568.00	89,826.53
87	Brooklyn conduit of City pipe-lines	Wm. F. Donovan and Charles Cranford	**Mar. 11	366,014.70	340,893.71
90	Completion of Hudson siphon in Hudson River division	The T. A. Gillespie Company	Mar. 23	1,649,020.00	1,496,829.43
91	Furnishing and installing racks, stop shutters, screens, lifters and other apparatus in gate-chambers	Vulcan Rail and Construction Company	Jun. 25	34,675.25	32,123.29
101	Fences at reservoirs and along Catskill aqueduct — District 1	The Degnon Contracting Company	Dec. 3	*67,731.20	67,662.23
	District 4	Abner M. Harper, Inc.	Feb. 12	65,402.50	48,708.56
	District 5	The Degnon Contracting Company	Dec. 2	33,484.50	22,075.28
103	Part of Queens conduit of City pipe-lines	Beaver Engineering and Contracting Company	**Feb. 18	344,053.00	343,813.64
107	Furnishing and installing gate and blow-off valves, Wallkill and Hudson blow-offs and City pipe-lines	The Chapman Valve Manufacturing Co.	May 4	121,620.50	123,044.97
111	Three concrete highway bridges, Ashokan reservoir	Ward and Tully, Inc.	Jul. 1	160,276.00	145,138.73
135	Maintenance buildings at Kensico dam	J. E. Butterworth	Feb. 24	*23,459.00	23,153.24
148	Portion of Catskill Aqueduct telephone system	Lord Electric Co.	Dec. 12	16,155.60	15,975.65
	Totals			***14,656,704.75	13,866,542.61
AC	General printing for 1913	The J. W. Pratt Company	Jul. 7	18,646.95	9,386.00
	Grand totals			***$14,675,351.70	$13,875,928.61

*Includes additional amount certified to be expended

**End of maintenance period; construction completed in 1913

***Does not include $9,908.08 additional certified in 1914 to be expended on Contract 93, completed in 1913

CONTRACT	DESCRIPTION OF WORK	LENGTH OF STRUCTURES	LOCATION	C
1	Test borings in and along shores of Hudson river..................C	....	Near New Hamburg and Storm King, Dutchess county........	*The Phoen... Company.
2	Mekeel, Garrison and Cat Hill tunnels and cut-and-cover...........C	10.7 miles	Towns of Cortlandt and Yorktown, Westchester county and Philipstown, Putnam county.........	Thomas M... Receiv... Benjamin...
3	Main dams, Ashokan reservoir......A	3.8 miles	Near Brown's Station, Towns of Olive and Marbletown, Ulster county.....................	MacArthur ... & C
4	Field office building for division and section engineers..............C	....	Town of Cortlandt, Westchester county...................	Daniel Car...
5	Portion of an intercepting sewer.....A	0.9 mile	City of Kingston, Ulster county...	Haggerty C...
6	Field office building for division and section engineers..............C	....	High Falls, Town of Marbletown, Ulster county................	John J. Mc...
7	Field office building for division and section engineers...........C, K	....	Town of Mt. Pleasant, near Valhalla, Westchester county.....	Shelley Bro...
9	Kensico dam......................K	1,900 feet		
	Dikes........................	1,000 feet		
	Pipe-lines....................	13,730 feet	Towns of Mt. Pleasant, Harrison	
	Bridges......................	1,554 feet	and North Castle, Westchester	
	Highways.....................	8.0 miles	county......................	**H. S. Ke...
10	Headworks of Catskill aqueduct.....C	0.8 mile	Town of Olive, Ulster county....	Jules Breu...
11	Esopus cut-and-cover and Peak tunnel.............................C	7.2 miles	Towns of Olive and Marbletown, Ulster county................	***H. S. K...
12	Rondout siphon and half Bonticou tunnel............................C	5.2 miles	Towns of Marbletown and New Paltz, Ulster county..........	The T. A. G...
15	Portion of Wallkill south cut-and-cover..........................C	3.0 miles	Towns of Gardiner, Plattekill and Shawangunk, Ulster county....	††The Elm... Company... Hand and...
16	Portion of St. Elmo cut-and-cover...C	2.4 miles	Town of Shawangunk, Ulster county....................	†††King, Ri...
17	St. Elmo siphon and cut-and-cover..C	2.7 miles	Towns of Shawangunk, Ulster county and Montgomery, Orange county.............	American P... Co.
18	Portion of Orange cut-and-cover....C	3.0 miles	Town of Montgomery, Orange county......................	American P... Co.
20	Moodna siphon..................C	4.8 miles	Towns of New Windsor and Cornwall, Orange county..........	Mason & H...
22	Bull Hill tunnel and cut-and-cover...C	1.5 miles	Town of Phillipstown, Putnam county......................	Patterson & ... James G. Shaw ...
23	Hunters Brook and Scribner tunnels and cut-and-cover...............C	2.3 miles	Town of Yorktown, Westchester county......................	Glyndon Co...
24	Croton Lake siphon, Turkey Mountain tunnel and cut-and-cover.........C	1.2 miles	Town of Yorktown, Westchester county......................	Bradley Co...
25	Croton and Chadeayne tunnels and cut-and-cover...................C	3.2 miles	Towns of Yorktown and Newcastle, Westchester county...........	Chas. W. B...
30	Hill View reservoir and portions of Yonkers and Van Cortlandt siphons ....C, H	....	City of Yonkers, Westchester county	Keystone S... Company.
31	Furnishing and installing four controlling valves for Ashokan reservoir...A	....	Town of Olive, Ulster county....	Ogden Iron ...turing Company.
34	Water-mains at Jerome Avenue pumping-station.....................K	1,490 feet	Borough of The Bronx, New York City.........................	Fox-Hennes...
38	Borings along City tunnel..........T	....	Boroughs of The Bronx, Manhattan and Brooklyn, New York City..	The Snare a...
39	Furnishing and installing pumping-plant at Jerome Avenue pumping-station..........................K	....	Borough of The Bronx, New York City.........................	Lord Electri...
40	Three field office buildings for section engineers.......................C	....	Towns of Olive and Marbletown, Ulster county................	John J. Wil...
41	Furnishing and installing sluice-gates and stop disks, Ashokan and Hill View reservoirs..............A, H	....	Town of Olive, Ulster county and City of Yonkers, Westchester county......................	Ogden Iron ...turing Company.
42	Furnishing and installing sluice-gates and gate-valves, Ashokan reservoir and Croton Lake siphon.......A, C	....	Towns of Olive, Ulster county and Yorktown, Westchester county.	Coffin Valve ...
43	Furnishing and installing sluice-gates and gate-valves, Ashokan, Kensico and Hill View reservoirs and along Catskill aqueduct.......A, K, H, C	....	....	Coffin Valve ...

Key for letters in 2nd column—Structure chargeable to

A—Ashokan reservoir
C—Catskill aqueduct
G—General; not chargeable to any one structure
H—Hill View reservoir
K—Kensico reservoir
S—Silver Lake reservoir
T—City tunnel and pipe-lines

*By ass...
**By ass...
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	Ho
...tion Company..	41 Park Row,
...npany; Receiver, Jr............	Newburg, N. Y
...nd Winston & Co.	Brown's Statio
....	Ossining, N. Y
...Co.............	215 West 125th
....	654 East 160th
....	Valhalla, N. Y.
....	30 Church St.,
....	290 Broadway
....	6 Church St.,
...mpany.........	50 Church St.,
...ion Contracting ...n, Augustus N. ...L. Selden........	49 Wall St., N
...y Company.....	280 Broadway
...struction Co.....	112 North Bro
...struction Co.....	112 North Bro
...pany...........	Cornwall-on-H
...: Receivers, James ...in Barker......	115 Broadway,
...Co...........	3785 Broadway
...Co............	1 Madison Ave
...Sons..........	New Haven, C
...ction Company.	704 Pennsylvan Pa.........
...Manufacturing	Bayonne, N. J
....	81 East 125th
...Co............	143 Liberty St
....	105 West 40th,
....	High Falls, N.
...d Manufacturing	147 Cedar St.,
....	Boston, Mass.
....	Boston, Mass.

...m American Diamond Rock D...
...m John C. Rodgers, James M. ...
...m H. S. Kerbaugh, April 3, 191...
...ification dated August 30, 1912...
...ntury Contracting Company, Ga...

Contract	Description of Work	Length of Structures	Location	Co
44	Sluice-gates, Ashokan, Kensico and Hill View reservoirs and along Catskill aqueduct.....A, K, H, C	....	....	Coldwell-Wilcox
45	Portion of Orange cut-and-cover....C	5.3 miles	Towns of Montgomery, Newburg and New Windsor, Orange county....................	Pittsburg Contra
47	Wallkill siphon, Mohonk and half Bonticou tunnels and cut-and-cover...C	9.0 miles	Towns of New Paltz and Gardiner, Ulster county..............	The Degnon Co
48	Portion of an intercepting sewer.....A	1.5 miles	City of Kingston, Ulster county...	King, Rice and G
49	Six reinforced concrete highway bridges, Ashokan reservoir...............A	1,367 feet	Town of Olive, Ulster county.....	⊙⊙The Harriso
50	Three field office buildings for section engineers.......................C	....	Towns of Yorktown and Newcastle, Westchester county.....	Joseph A. Dassle
52	Eastview, Elmsford and Elmsford south tunnels and cut-and-cover...C	4.5 miles	Towns of Mt. Pleasant and Greenburg, Westchester county......	Pittsburg Contra
53	Platt Avenue siphon and cut-and-cover.........................C	4.7 miles	Town of Greenburg and City of Yonkers, Westchester county...	⊙⊙⊙The Elmsf ing Company; N. Hand and S
54	Part of Yonkers siphon............C	2.1 miles	City of Yonkers, Westchester county....................	George W. Jack ceiver, W. W. (
55	Portion of Catskill aqueduct in Croton and Kensico divisions and works at Kensico reservoir ....C, K	9.5 miles	Towns of Newcastle and Mt. Pleasant, Westchester county.......	Rinehart & Dens
56	Power-plant equipment for gate operation and lighting, Ashokan reservoir, A	....	Town of Olive, Ulster county.....	L. K. Comstock
57	Power-plant equipment for gate operation and lighting, Kensico reservoir, K	....	Westchester county...............	....
58	Drainage equipment, Rondout siphon C	....	Town of Marbletown, Ulster county.....................	△D'Olier Centr chine Co.....
59	Constructing highways, Ashokan reservoir.........................A	27.5 miles	Towns of Olive, Marbletown, Hurley, Woodstock and Kingston, Ulster county................	The C. P. Bower
60	Hurley dikes at Ashokan reservoir...A	1.6 miles	Towns of Hurley and Kingston, Ulster county................	MacArthur Broth
61	Wallkill blow-off................C	1.3 miles	Town of Gardiner, Ulster county..	△△The Harriso △△△Century C
62	Seven steel-pipe siphons...........C	4.3 miles	Towns of Olive, New Windsor, Phillipstown and Cortlandt....	The Snare & Tri ‡Steel & Masonry
63	Portion of City tunnel............T	4.0 miles	City line to Burnside and Aqueduct avenues, The Bronx, New York City..................	Mason and Hang
65	Portion of City tunnel............T	5.4 miles	Burnside and Aqueduct avenues, The Bronx, to Central park at West 99th street, Manhattan, New York City.............	Pittsburg Contra
66	Portion of City tunnel............T	4.4 miles	Central park at West 99th street, to 14th street in Union square, Manhattan, New York City....	Grant Smith & C
67	Portion of City tunnel............T	4.0 miles	14th street in Union square, Manhattan, to 3rd avenue and Schermerhorn street and Fort Greene park, Brooklyn, New York City.	Holbrook, Cabot tion, Geo. B.
68	Seven steel-pipe siphons............C	2.7 miles	Towns of Yorktown, Mt. Pleasant and Greenburg and City of Yonkers, Westchester county...	‡‡The T. A. Gill ‡‡‡Pittsburg Con
70	Furnishing bronze gate-valves for City tunnel.........................T	....	Boroughs of The Bronx and Manhattan, New York City........	Paul S. Reeves
72	Clearing and grubbing Ashokan reservoir..........................A	....	Towns of Olive, Marbletown, Hurley, Woodstock and Kingston, Ulster county................	J. F. Cogan Com
73	Borings along City tunnel..........T	....	Boroughs of Manhattan and Brooklyn, New York City.....	Sprague & Henw
74	Field office building for division and section engineers................C	....	Town of Greenburg, Westchester county......................	Joseph A. Dassl
75	Bay Ridge conduit.................T	3.1 miles	36th street and 5th avenue to 79th street and Shore road, Brooklyn, New York City.....	F. V. Smith & S
76	Ashokan bridge, Ashokan reservoir..A	1,120 feet	Town of Olive, Ulster county.....	Transit Constru
77	Wakefield Avenue blow-off from Hill View reservoir..................H	3,000 feet	City of Yonkers, Westchester county......................	Geo. L. Brown

Key for letters in 2nd column—Structure chargeable to

A—Ashokan reservoir
C—Catskill aqueduct
G—General; not chargeable to any one structure
H—Hill View reservoir
K—Kensico reservoir
S—Silver Lake reservoir
T—City tunnel and pipe-lines

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Company....	60 Wall St., N.
o............	280 Broadway,
tion Company..	220 Broadway,
....	Hawthorne, N.
ompany.......	1942 Forbes St.
milton Contractors, Augustus L. Selden.....	49 Wall St., N.
corporated; Re-d...........	Chicago, Ill...
....	Charlottesville,
pany..........	30 Church St.,
....	....
Pump & Ma-.............	Morris Buildin
ruction Company	Bulletin Buildi
ompany........	11 Pine St., N.
nce Company..	220 Broadway,
ting Company..	115 Broadway,
....	143 Liberty St.
ting Company	233 Broadway,
mpany.........	Van Cortlandt
Company.......	1942 Forbes St.
Locker..........	18 East 41st St
Rollins Corpora-Thos. B. Bryson	103 Park Ave.,
ompany........	50 Church St.,
ng Company....	1942 Forbes St.
....	1415 Catherine
Contractors....	280 Broadway,
....	Scranton, Pa..
....	Hawthorne, N.
....	Turnbull Ave. N. Y. City..
Company.......	Mt. Vernon, N.
J. Brown.......	87 Hamilton Pl

odification dated March 10, 191
om Harrison and Burton, June 2
eorge Sargent, Jr. and John C. S
om D'Olier Engineering Compan
om Harrison and Boice, July 2d, 19

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Contract	Description of Work	Length of Structures	Location	C…
79	Elmsford and Bryn Mawr blow-offs. C	1.7 miles	Town of Greenburg and City of Yonkers, Westchester county..	Thomas O'… ¶Grannis…
80	Breakneck siphon and tunnel.......C	0.5 mile	Towns of Fishkill, Dutchess county and Phillipstown, Putnam county....................	The Dravo…
81	Four field office buildings for section engineers......................C	....	Towns of Mt. Pleasant and Greenburg and City of Yonkers, Westchester county...............	John F. H…
83	Furnishing and erecting telephone poles.........................G	....	Along Catskill aqueduct.........	Carpenter &…
84	Furnishing bronze shaft caps for City tunnel ....T	....	Boroughs of The Bronx, Manhattan and Brooklyn, New York City........................	American M…
86	Part of Queens conduit............T	2.4 miles	Fort Greene park to Willoughby avenue and Broadway, Borough of Brooklyn, New York City...	Beaver En…
87	Brooklyn conduit................T	3.2 miles	3rd avenue and Schermerhorn street to 36th street and 5th avenue, Brooklyn, New York City........................	Wm. F. Do…
88	Part of Richmond conduit ....T	0.8 mile	Foot of Arrietta street to Richmond turnpike at Woodstock avenue, Borough of Richmond, New York City..............	Beaver Eng… C…
89	Silver Lake reservoir and part of Richmond conduit................S, T	....	Borough of Richmond, New York City........................	Beaver Eng… C…
90	Completion of Hudson siphon C	3,022 feet	Towns of Cornwall, Orange county and Fishkill, Dutchess county..	The T. A. …
91	Furnishing and installing racks, stop shutters, screens, lifters and other apparatus in gate-chambers. A, H, C	....	Along Catskill aqueduct..........	Vulcan Rail…
93	Portion of Catskill Aqueduct telephone system ....G	65 miles	From Ashokan reservoir to Croton lake..................	New York T…
94	Furnishing and erecting steel floats for drainage shafts C	....	Wallkill, Hudson and Croton Lake siphons....................	J. Edward …
95	Cranes for pressure tunnel and siphon chambers.....................C	....	....	…
98	Borings along City tunnel ....T	....	Boroughs of Manhattan and Brooklyn, New York City.....	The Healey … struction C…
99	Narrows siphon ....T	1.9 miles	Boroughs of Brooklyn and Richmond, New York City........	Merritt & C… ing Co.…
100	Extension of Croton blow-off into Croton lake.......................C	155 feet	Town of Yorktown, Westchester county....................	Stobaugh C…
101	Fences: District 1................A	40.9 miles	At reservoirs and along Catskill aqueduct..................	The Degn…
	District 2................C	13.2 miles		
	District 3................C	19.7 miles		
	District 5................C	16.7 miles		
	District 6................C	23.7 miles		
	District 4................C	45.6 miles		Abner M. …
103	Part of Queens conduit............T	3.9 miles	Willoughby avenue and Broadway, Brooklyn, to Queens Boulevard, Queens, New York City.......	Beaver E… Company
104	Furnishing and installing gate, controlling and other valves and sluice-gates for City aqueduct and Croton Lake siphon.................C, T	....	Town of Yorktown, Westchester county and New York City....	Coffin Valve…
105	Furnishing and installing bronze riser valves and appurtenances for City tunnel..........................T	....	Boroughs of The Bronx, Manhattan and Brooklyn, New York City........................	The Exeter …
106	Aerator nozzles..................A, K	....	Ashokan and Kensico reservoirs..	....
107	Furnishing and installing gate and blow-off valves, Wallkill and Hudson blow-offs and City pipe-lines...C, T	....	Towns of Gardiner, Ulster county and Fishkill, Dutchess county and New York City..........	The Chapm…
109	Five superstructures for Foundry Brook and Indian Brook siphon chambers and Breakneck Gaging chamber...C	....	Towns of Fishkill, Dutchess county and Phillipstown, Putnam county.....................	A. L. Guid…

Ke…
A—Ashokan …
C—Catskill …
G—General; …
aq…

	Hom
.... racting Co..	46 Laighton Ave., Ossining, N. Y..
npany.....	814 Lewis Block,
....	Mt. Vernon, N. Y
....	Paterson, N. J..
se Company.	99 John St., N. Y
stracting Co.	51 Chambers St.,
les Cranford.	186 Remsen St.,
stracting Co.	51 Chambers St.,
ntracting Co.	51 Chambers St.
any.........	50 Church St., N
tion Company	35 Meserole Ave
npany.......	15 Dey St., N. Y
ny..........	147-149 Cedar St
....	....
ine and Con-...........	21 Park Row, N.
ick & Wreck-...........	17 Battery Place
mpany.......	1 Madison Ave.,
ompany....	30 East 42nd St.
....	Newburg, N. Y.
Contracting	182 Broadway, N
....	Neponset, Bosto
a..........	Pittston, Pa....
....	....
ufacturing Co.	Indian Orchard,
any.........	162 East 23rd St

n 2nd column—Structure charge
H—Hill View
K—Kensico re
le to S—Silver Lak
T—City tunne

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Contract	Description of Work	Length of Structures	Location	(
110	Furnishing and installing gaging, metering and other apparatus. A, K, H, C		At reservoirs and along Catskill aqueduct	Builders Ir
111	Three concrete highway bridges, Ashokan reservoir. A	717 feet	Towns of Olive and Marbletown, Ulster county	Ward and
112	Furnishing and installing ladders, gratings, railings and plates, Ashokan Upper gate-chamber. A		Town of Olive, Ulster county	Vulcan Rai
113	Test-pits and borings on site of Silver Lake reservoir. S		Borough of Richmond, New York City	Sweeney &
114	Furnishing pressure-regulating valves for City tunnel and pipe-lines. T		Boroughs of The Bronx, Manhattan and Brooklyn, New York City	Coffin Val
117	Seven superstructures for Peak, Rondout, Wallkill and Washington Square siphon, blow-off, drainage and gaging chambers. C		Towns of Marbletown and Gardiner, Ulster county and New Windsor, Orange county	Michael St
118	Eleven superstructures for Sprout Brook, Peekskill, Hunters Brook, Turkey Mountain and Harlem Railroad siphon and Croton Gaging chambers. C		Towns of Phillipstown, Putnam county and Cortlandt, Yorktown and Mt. Pleasant, Westchester county	A. L. Guid
120	Hudson Drainage and Croton Downtake Chamber superstructures. C			
121	Five superstructures for Elmsford, Fort Hill and Bryn Mawr siphon chambers. C		Town of Greenburg and City of Yonkers, Westchester county	Joseph Bal
123	Six superstructures for Kensico Influent, Upper and Lower Effluent and Screen chambers and Kensico siphon chambers. C, K		Town of Mt. Pleasant, Westchester county	
124	Nine superstructures for Ashokan Upper and Lower Gate, Screen and Gaging chambers and Esopus and Tongore siphon chambers, and balustrades and cartouches for Ashokan bridge. A, C		Town of Olive, Ulster county	Michael St
125	Ashokan superintendent's buildings. A			
127	Kensico superintendent's buildings. K			
128	Hill View Uptake and Downtake Chamber superstructures. H		City of Yonkers, Westchester county	
129	Morningside Park and East River Drainage Chamber superstructures. T		Borough of Manhattan, New York City	
132	Borings at Silver Lake reservoir. S		Borough of Richmond, New York City	Healey Co
135	Maintenance buildings at Kensico dam. K		Town of North Castle, Westchester county	J. E. Butt
136	Improving stream and margin of waterways			
137	Inspection and maintenance equipment			
138	Trees, shrubs and seeds			
139	Sewerage system, Esopus watershed			
140	Floats for Shafts 11 and 21 of City tunnel. T			
142	Removal of chestnut growth around Kensico reservoir. K		Towns of Mt. Pleasant, North Castle and Harrison, Westchester county	Charles C
143	Fences and miscellaneous work in the vicinity of Ashokan reservoir. A	17 miles	Towns of Olive, Marbletown and Hurley, Ulster county	
144	Parapets along Dividing dike and shelter over gate-chamber, Silver Lake reservoir. S			
145	Roofing, with reinforced concrete tiles, various superstructures along Catskill aqueduct. C		Between Ashokan and Hill View reservoirs	American
146	Furnishing valves, hydraulic cylinders and piping for City tunnel. T		Boroughs of The Bronx, Manhattan and Brooklyn, N. Y. City	Caldwell-
147	Riser-valve controlling apparatus. T		Boroughs of The Bronx, Manhattan and Brooklyn, N. Y. City	
148	Portion of Catskill Aqueduct telephone system. G	28 miles	Between Croton lake and New York City	Lord Elec
149	Stop shutters, racks, trucks, etc., for Ashokan and Kensico reservoirs. A, K			

Key for letters in

A—Ashokan reservoir

C—Catskill aqueduct

G—General; not chargeabl
any one structure

H

....	Providence, F
....	Brown's Stati
tion Company	175 North 9t
y...........	81 6th St., L
....	Neponset, Bo
....	Box 163, Gar
y...........	131 East 23rd
....	....
....	261 Broadway
....	....
....	14 Ward Ave.
....	....
....	....
....	....
....	....
ipany........	21 Park Row,
....	5 Colden Ave.
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....	345 55th St.,
....	....
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lfg. Co.......	29 Broadway,
y...........	Newburg, N.
....	....
....	105 West 40t
....	....

Structure chargeable to
-Hill View reservoir
-Kensico reservoir
-Silver Lake reservoir
-City tunnel and pipe-lines

Contract	Description of Work	Length of Structures	Location
151	Surfacing with bituminous pavement and waterbound macadam portions of highways at Ashokan reservoir..A	33 miles	Towns of Olive, Marbletown, Hurley, Woodstock and Kingston, Ulster county................
152	Surfacing with vitrified brick block and macadam portions of highways and constructing guard walls at Ashokan reservoir.......................A	5 miles	Towns of Olive, Marbletown and Hurley, Ulster county.........
154	Cast-iron gate-valves for operating mechanisms, City tunnel.........T	....	Boroughs of The Bronx, Manhattan and Brooklyn, N. Y. City..
156	Furnishing and planting tree transplants at Ashokan and Kensico reservoirs.......................A, K	....	Ulster and Westchester counties..
157	Planting at Hill View reservoir.....H	....	City of Yonkers, Westchester county......................
158	Filling expansion joints, Olive Bridge dam...........................A	....	Town of Olive, Ulster county....
159	Plant for removal of color and turbidity C	....	Town of Mt. Pleasant, Westchester county...............
160	Moodna Siphon supplementary shaft and tunnel C	900 feet	Town of Cornwall, Orange county
161	Motors, drives and wiring for gang drives, Ashokan reservoir.........A	....	Town of Olive, Ulster county....
162	About 8,000 square feet of face cutting of stones for Kensico dam....K	....	Town of North Castle, Westchester county....................
163	Excavation for and laying pipe and special belting for operating mechanisms for riser valves of City tunnel....T	....	Boroughs of The Bronx, Manhattan and Brooklyn, New York City.........................
	Totals..............................		
A	Printing 1906 annual report........G	....	....
B	Class A—Engineering supplies and instruments.......................G	....	....
B	Class B—Stationery supplies.......G	....	....
B	Class C—Printed forms............G	....	....
B	Class D—Hardware.................G	....	....
C	Horses for patrolmen on aqueduct...G	....	....
D	Printing 1907 annual report........G	....	....
E	General printing for 1909..........G	....	....
G	Class 1—8,000 tons of bituminous coal...........................C	....	Hudson River test-shafts........
G	Class 2—80 tons of Cumberland coal.C	....	Hudson River test-shafts........
H	Class M—Boilers C	....	Hudson River test-shafts........
I	Class D—Lead seals......A, K, H, C	....	Cement mills..............
J	Class A—Sunflower instruments....C	....	Along line of Catskill aqueduct...
J	Class K—Lumber C	....	Hudson River test-shafts........
J	Class L—Millwork..................C	....	Hudson River test-shafts........
K	Class F—Oils......................C	....	Hudson River test-shafts........
N	Class 1—Furniture.................G	....	....
N	Class 2—Furniture.................G	....	....
O	Horses for patrolmen on aqueduct..G	....	....
P	Class F—Oils......................C	....	Hudson River test-shafts........
Q	General printing for 1910..........G	....	....
R	Class 1—15,000 tons of bituminous coal...........................C	....	Hudson River test-shafts........
R	Class 2—120 tons of Cumberland coalC	....	
T	Horses for patrolmen on aqueduct...G	....	....
U	Class M—Boilers..................C	....	Hudson River test-shafts........
V	Class K—Lumber...................C	....	Hudson River test-shafts........
W	Printing minutes of Board for 1910..G	....	....
X	General printing for 1911..........G	....	....
Y	Class D—Miscellaneous hardware...G	....	....
Y	Class O—Engineering supplies......G	....	....
Z	Class B—Stationery supplies.......G	....	....
AA	General printing for 1912..........G	....	....
AB	Horses for patrolmen on aqueduct..G	....	....
AC	General printing for 1913..........G	....	....
AE	General printing for 1914..........G	....	....
AF	General printing for 1915 and 1916..G	....	....
	Totals..............................		
	Grand totals..............................		

Key for le

A—Ashokan rese

C—Catskill aque

G—General; not

one struct

Home

Co....... Beacon, N. Y...

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Company
npany.... Cheshire, Conn..

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.... 233 Broadway, N

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.... 52 Duane St., N

.... 46 East 14th St.
.... 52 Duane St., N
.... 4077 Park Ave.,
.... 127 Reade St., N
any.. 153 East 24th St
nd Pub-
.... 24 Vandewater S
.... 52 Duane St., N

.... 1 Broadway, N.
.... 1 Broadway, N.
.... 149 Broadway,
.... 227 Fulton St.,
.... 127 Fulton St.,
.... 81 Bridge St., B
.... Kingston, N. Y.
.... 138 Front St., N
.... 59-67 Myrtle Av
.... 784 Broadway,
mpany.. 153 East 24th S
.... 138 Front St., N
y...... 49 Park Place, N

.... 1 Broadway, N.

pany.. 153 East 24th St
.... 70 Warren St.,
.... 85 Bridge St., B
.... 9 Franklin St.,
.... Washington and
lyn, N. Y....
.... 133 Fourth Ave.
.... 127 Fulton St.,
y Com-
.... 306 Broadway,
g Co... 53 Park Place,
mpany.. 153 East 24th S
.... 52 Duane St., N
g Co... 53 Park Place,
.... 52 Duane St., N

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ture chargeable to
H—Hill View reservoir
K—Kensico reservoir
S—Silver Lake reservoir
T—City tunnel and pipe-

Amounts of Contracts Awarded to December 31, 1914, Classified by Years and Structures

Year	Ashokan Reservoir	Kensico Reservoir	Hill View Reservoir	Silver Lake Reservoir	Catskill Aqueduct	City Tunnel and Pipe-Lines	General Purposes	Totals
1906	....	....	....	....	$79,775.00	....	....	$79,775.00
1907	$12,684,343.35	....	....	....	4,227,743.00	....	....	16,912,086.35
1908	....	....	....	....	9,627,556.00	$105,678.00	$12,869.67	9,746,103.67
1909	1,496,667.00	$7,987,934.00	$3,269,280.00	....	25,393,807.82	46,650.00	39,124.58	38,233,463.40
1910	160,142.00	26,859.00	68,680.00	....	5,436,601.00	39,175.00	300,338.11	6,031,795.11
1911	273,591.50	....	58,178.25	$4,745.00	1,737,277.50	20,031,704.70	144,632.46	22,250,129.41
1912	663,906.50	22,459.00	....	4,524.85	624,301.25	13,405.00	30,747.95	1,359,344.55
1913	672,450.00	12,900.00	....	821,130.00	222,976.96	682,128.60	60,264.60	2,471,850.16
1914	133,132.20	....	....	....	526,301.00	1,369,457.50	639,215.73	2,668,106.43
Totals	$16,084,232.55	$8,050,152.00	$3,396,138.25	$830,399.85	$47,876,339.53	$22,288,198.80	*$1,227,193.10	$99,752,654.08

Amounts of Agreements Awarded to December 31, 1914, Classified by Years and Structures

Year	Prattsville Reservoir	Ashokan Reservoir	Kensico Reservoir	Suffolk County Sources	Catskill Aqueduct	City Tunnel and Pipe-Lines	General Purposes	Totals
1905	....	....	....	....	$29,291.57	....	....	$29,291.57
1906	....	$53,959.78	$6,300.00	$5,537.94	139,141.77	....	....	204,939.49
1907	....	25,000.00	4,268.46	8,633.70	403,741.86	$4,997.63	....	446,641.65
1908	....	....	....	....	59,383.06	....	....	59,383.06
1909	....	....	....	....	40,000.00	....	$13,263.62	53,263.62
1910	....	....	....	....	42,750.00	....	10,680.00	53,430.00
1911	....	**2,801,711.00	....	....	....	....	13,821.63	2,815,532.63
1912	....	....	....	....	....	....	21,920.00	21,920.00
1913	....	....	....	....	5,719.00	....	20,499.00	26,218.00
1914	$11,100.00	....	....	....	....	....	23,000.00	34,100.00
Totals	$11,100.00	$2,880,670.78	$10,568.46	$14,171.64	$720,027.26	$4,997.63	***$103,184.25	$3,744,720.02

* Includes Contracts C, O, T, W and AB for $59,997.50 for Police and Administration bureaus
** Includes Agreement 82 for $2,800,000 for Administration bureau
*** Includes Agreements 79, A, B, C, D, E, F, G, H, I, J, K, L and M for $103,105.25 for Administration bureau

TABLE 11

Summary of Amounts and of Gross Estimates of Work Done on Contracts to December 31, 1914

	Year	Amounts of Contracts: Awarded	Amounts of Contracts: Completed	Amounts of Contracts: Under Way at End of Year	Gross Estimates of Work Done: On Contracts Under Way at End of Year	Gross Estimates of Work Done: On Contracts Completed	Gross Estimates of Work Done: All Contracts
During and at end	1906	$79,775.00	....	$79,775.00	$22,983.75	....	$22,983.75
During	1907	16,912,086.35	....	....	....	....	228,132.60
At end	1907	16,991,861.35	....	16,991,861.35	228,132.60	....	251,116.35
During	1908	9,746,103.67	$27,353.19	....	....	$26,461.74	1,877,789.58
At end	1908	26,737,965.02	27,353.19	26,710,611.83	2,102,444.19	26,461.74	2,128,905.93
During	1909	38,233,463.40	54,935.55	....	....	54,716.20	7,713,422.82
At end	1909	64,971,428.42	82,288.74	64,889,139.68	9,761,150.81	81,177.94	9,842,328.75
During	1910	6,031,795.11	493,703.18	....	....	401,079.05	15,600,268.21
At end	1910	71,003,223.53	575,991.92	70,427,231.61	24,960,339.97	482,256.99	25,442,596.96
During	1911	22,250,129.41	133,033.86	....	....	130,658.43	19,104,290.26
At end	1911	93,253,352.94	709,025.78	92,544,327.16	43,933,971.80	612,915.42	44,546,887.22
During	1912	1,359,344.55	6,228,756.06	....	....	5,912,826.06	19,459,969.70
At end	1912	94,612,697.49	6,937,781.84	87,674,915.65	57,481,115.44	6,525,741.48	64,006,856.92
During	1913	2,471,850.16	26,760,630.06	....	....	25,418,869.86	15,053,256.33
At end	1913	97,084,547.65	33,698,411.90	63,386,135.75	47,115,501.91	31,944,611.34	79,060,113.25
During	1914	2,668,106.43	14,685,260.36	....	....	13,875,928.61	11,026,494.57
At end	1914	99,752,654.08	48,383,672.26	51,368,981.82	44,266,067.87	45,820,539.95	90,086,607.82

TABLE 12

* Agreements Prepared or in Preparation During 1914

Agreement	Description of Work	Contractor	Bids Opened 1914	Date of Award 1914	Date of Agreement 1914	Amount
90	Gaging-machines for Catskill aqueduct..........	....	....	....	....	....
**91	Cutting granite frieze of Kensico dam..........	....	Jun. 16	....	....	....
**92	Motor-boat for Ashokan reservoir...............	....	....	....	....	....
95	Test borings in Schoharie, Greene and Delaware counties	Giles & Clark, 30 Church street, New York City....	Nov. 10	Nov. 12	Nov. 13	***......
J	Maintenance of aqueduct telephone line from Croton lake to Ashokan reservoir.................	New York Telephone Company, 15 Dey street, New York City	....	....	Jan. 12	$1,500.00
K	Telephone service in 1914 in New York City and Westchester and Putnam counties.............	New York Telephone Company, 15 Dey street, New York City	....	....	Jan. 1	8,500.00
L	Sanitary services for 1914.......................	Herbert D. Pease and A. J. Provost, Jr., 39 West 38th street, New York City....	....	....	Jan. 11	8,000.00
M	Maintenance of aqueduct telephone line and telephone service between Ashokan reservoir and Municipal building, New York City............	New York Telephone Company, 15 Dey street, New York City	....	....	Oct. 16	5,000.00 per year
**Contract 9, 3rd modification	Cutting stones for frieze course of Kensico dam..	....	....	....	....	....
Contract 104, Modification	Eliminating certain valves and providing for other valves for City tunnel.......................	Coffin Valve Company, Neponset, Boston, Mass.....	....	....	Jul. 28	....
Contract 118, Modification	Substituting reinforced-concrete stone for bluestone or granite as crane-rail courses..........	A. L. Guidone and Company, 131 East 23rd street, New York City	....	....	Oct. 28	....

* For agreements prepared before 1914 see previous annual reports

** Not executed

*** Unit prices: borings, first 100 feet, $2.75 per foot; 100 to 200 feet, $2.75 per foot; beyond 200 feet, $2.75 per foot; casing left in place, $0.05 per pound

TABLE 13

Length of Catskill Aqueduct in Feet from Ashokan Reservoir to Termini in Queens Borough and Staten Island

Division	Contract	Cut-and-Cover	Grade Tunnel	Pressure Tunnel	*Pressure Aqueduct	**Steel-Pipe Siphon	Pipe Conduit	Length of Contract in Division	Length of Aqueduct in Division
RESERVOIR DEPARTMENT									
Olive Bridge.....	3	..	......	.....	587	......	.....	587	
" "	10	3,054	......	.....	1,245	......	.....	4,299	[illegible]
Totals for department.		**3,054**	.....	.....	**1,832**	......	.....	.....	**[illegible]**
NORTHERN AQUEDUCT DEPARTMENT									
Esopus..	11	34,352	3,470	......	......	......	.....	37,822	
"	12	602	3,340	23,608	......	......	......	27,550	
"	62	201	......	......	......	2,756	....	2,957	68,33[illegible]
Wallkill	47	20,006	4,010	23,391	......	......	......	47,407	
"	15	***15,900	......	......	......	......	.....	15,900	63,3[illegible]
Newburg........	16	12,700	.....	...	......	......	.....	12,700	
"	17	†14,100	......	......	......	......	.....	14,100	
"	18	15,600	......	......	......	.....	......	15,600	
"	45	28,190	.....	....	......	.....	......	28,190	
"	62	100	......	.....	......	3,267	......	3,367	73,3[illegible]
Hudson River....	20	395	......	††25,200	......	.....	......	25,595	
"	90	.....	......	3,022	......	.....	.....	3,022	
"	80	710	‡1,080	‡‡793	......	......	...	2,583	
"	22	2,362	5,365	.....	......	..	....	7,727	
"	62	1,777	......	.....	......	3,737	....	5,514	44,44[illegible]
Peekskill........	2	41,851	14,680	.....	......	...	.....	56,531	
"	62	1,635	....	.....	......	9,310	.....	10,945	67,47[illegible]
Totals for department..		**190,481**	**31,945**	**76,014**	......	**19,070**	....	......	**317,5[illegible]**

TABLE 13 (*Concluded*)

Division	Contract	Cut-and-Cover	Grade Tunnel	Pressure Tunnel	*Pressure Aqueduct	**Steel-Pipe Siphon	Pipe Conduit	Length of Contract in Division	Length of Aqueduct in Division
SOUTHERN AQUEDUCT DEPARTMENT									
Croton..........	23	5,445	6,450	......	......	......	......	11,895	
"	24	2,118	1,400	2,639	......	......	......	6,157	
"	25	13,248	3,700	......	......	......	......	16,948	
"	55	14,539	15,430	......	1,035	......	......	31,004	
"	68	511	...	......	......	3,652	......	4,163	70,167
Kensico.........	55	261	4,316	......	14,549	......	......	19,126	19,126
White Plains....	52	14,409	8,725	......	484	......	......	23,618	
"	53	24,438	......	......	138	......	......	24,576	
"	68	289	......	......	18	4,346	......	4,653	52,847
Hill View	54	.....	.....	§11,178	......	.....	.....	11,178	
"	30	..	.....	2,999	2,859		......	5,858	
"	68	52	.....	...	-	5,571	......	5,623	22,659
Totals for department.	..	75,310	40,021	16,816	19,083	13,569	......	......	164,799
CITY AQUEDUCT DEPARTMENT									
Bronx	63	......	......	21,267	......	......	......	21,267	
"	65	......	......	28,319	......	......	......	28,319	49,586
Manhattan	66	......	......	23,140	......	......	......	23,140	
"	67	......	......	21,177	......	......	......	21,177	44,317
Conduit and Reservoir	87	......	......	......	......	......	17,116	17,116	
"	75	......	......	......	......	......	16,289	16,289	
"	99	......	......	......	......	......	10,620	10,620	
"	88	......	......	......	......	......	4,092	4,092	
"	86	......	......	......	......	......	12,514	12,514	
"	103	......	......	......	......	......	20,815	20,815	
"	89	......	......	......	......	......	5,800	5,800	87,246
Totals for department		......	......	93,903	......	......	87,246	......	181,149
Grand totals ..		268,845	71,966	186,733	20,915	32,639	87,246	......	668,344

Cut-and-cover extends to center lines of end shafts of pressure tunnels and includes chambers at ends of steel-pipe siphons, Kensico Influent chamber and the Filter Connection chamber

Pressure tunnel is measured from center lines of end shafts

*Includes special structures in the Headworks, reinforced-concrete siphons, Venturi meters, Hill View by-pass and all aqueduct structures in open cut between Kensico Influent chamber and Filter Connection chamber

**Horizontal lengths

***Includes 100 feet of cut-and-cover and Blow-off chamber done under Contract 61

†Includes St. Elmo reinforced-concrete siphon

††Includes 119±feet of Moodna pressure tunnel constructed under Contract 90

‡Includes siphon chamber at north portal of Breakneck tunnel = 26 feet

‡‡Includes 11±feet of Breakneck pressure tunnel constructed under Contract 90

§Includes connection chamber at north end of Yonkers pressure tunnel

*Progress in Linear Feet in La

Contract	Jan.		Feb.		Mar.		Apr.		May		Ju
	Invert	Arch	Invert	Arch	Invert	Arch	Invert	Arch	Invert	Arch	Invert
55	46	63	52	83	..	..	..	..	..	..	..
30	15	15	..	..	..	..	90	90	135	135	40
Totals ..	61	78	52	83	..	..	90	90	135	135	40

* Includes pressure aqueduct and various special structures † Includes 16 feet not rep
10, 3,462 feet—Northern Aqueduct department: Contract 2, 41,851 feet; Contract 11, 34,352
tract 20, 337 feet; Contract 22, 2,362 feet; Contract 45, 28,191 feet; Contract 47, 19,900
24, 2,003 feet; Contract 25, 13,248 feet; Contract 52, 14,781 feet; Contract 53, 24,576 feet; Cont

TABLE 14

ONCRETE FOR CUT-AND-COVER SECTIONS TO D

ES DURING 1914						
JUL.		AUG.		SEP.		OCT
Invert	Arch	Invert	Arch	Invert	Arch	Invert
SOUTHERN AQUEDUCT DEPARTMENT						
..	..	..	..	..	..	..
..	..	..	..	..	..	..
..	..	..	..	..	..	..

1913 ‡Completed § Includes lengths in followin
ontract 12, 405 feet; Contract 15, 15,800 feet; Contr
ntract 61, 100 feet; Contract 62, 3,049 feet; Contract 8
204 feet

Contract Number and Name of Pressure Tunnel	Between Shafts	Jan. Invert	Jan. Side walls	Jan. Arch	Inve
Contract 160—Moodna	7-A and 8	....	....	....	....
Totals for department		....	....	....	....
Contract 63—City	End of Contract and 1	....	868	864	....
	1 and 2	....	....	....	....
	2 and 3	....	624	703	....
	3 and 4	....	69	....	....
	4 and 5	31	....	....	....
	5 and End of Contract	988	297	128	....
Totals		1,019	1,858	1,695	....
Contract 65—City	End of Contract and 6	1,544	....	....	....
	6 and 7	....	594	489	....
	7 and 8	....	....	....	....
	8 and 9	....	....	....	283
	9 and 10	....	....	....	1,072
	10 and 11	1,277	972	865	679
	11 and 12	584	100	....	....
	12 and End of Contract	128	778	590	....
Totals		3,533	2,444	1,944	2,034
Contract 66—City	End of Contract and 13	9	9	9	....
	13 and 14	12	12	12	....
	14 and 15	....	....	....	....
	15 and 16	....	....	....	....
	16 and 17	....	....	....	....
	17 and 18	....	....	....	....
	18 and End of Contract	23	11	6	11
Totals		44	32	27	11
Contract 67—City	End of Contract and 19	....	1,017	1,015	....
	19 and 20	....	1,738	1,737	....
	20 and 21	....	1,343	1,152	....
	21 and 22	....	1,238	1,237	....
	22 and 23	....	995	992	....
	24 West	....	....	....	....
Totals		....	6,331	6,133	....
Totals for department		4,596	10,665	9,799	2,045
Grand totals		4,596	10,665	9,799	2,045

* Completed ** Includes distances in Rondout, Wallkill and Hudson pressure tunnels and betv

TA

CANVASS OF BIDS OPENED JUNE 23, 1914, FOR **Contract 76,** FOR THE CONST

ITEM	DESCRIPTION	UNIT	QUANTITY	*A	B	C
1	Earth excavation....................	Cubic yard..	4,300	$0.55	$1.30	$0.60
2	Rock excavation....................	" ..	50	2.50	4.00	5.00
3	Porous filling on bridge................	" ..	450	1.50	1.00	2.00
4	Portland cement....................	Barrel.......	9,500	1.55	2.00	1 65
5	Concrete, Class A....................	Cubic yard..	1,550	6.00	11.19	10.00
6	Concrete, Class B....................	" .	5,100	11.00	10.94	13.00
7	Surface finish of concrete..............	Square foot..	27,000	10	.10	.05
8	Steel for reinforcing concrete, consisting of structural shapes with riveted or bolted connections.................	Pound......	28,000	.045	045	045
9	Steel for reinforcing concrete, not included in Item 8..................	"	500,000	03	.03	.035
10	Miscellaneous cast iron, wrought iron and steel........................	"	58,000	045	.04	05
11	Bronze...........................	"	500	.30	1 00	.60
12	Vitrified pipe......................	Linear foot..	3,000	.25	.50	50
13	Electrical conduits....................	Linear foot of single duct.	66,000	.10	.09	.10
14	Crushed stone and gravel..............	Cubic yard..	50	2.50	2.50	3.00
15	Timber and lumber..................	M ft. B.M...	10	55.00	50.00	50.00
16	Cleaning up.......................	Lump sum...	......	1,500.00	100 00	1 00
	Amounts of bids..................................			$114,535.00	[illegible]	[illegible]

Time: November 1, 1915 Bond required: $70,000 *Awarded contract A—Transit Construction Comp
Company, Inc., 299 Madison Ave., New York City D—J. F. Cogan Co., Contractors, Woolworth Building, N
Long Island, N. Y. and 615 Charles St., West Hoboken, N. J. G—Ward and Tully, Inc., Brown's Station, N. Y
Fourth Ave., Pittsburg, Pa. J—The Degnon Contracting Company, 30 East 42nd St., New York City K—

OF ASHOKAN BRIDGE, IN THE TOWN OF OLIVE, ULSTER COUNTY, NEW YORK

E	F	G	H	I	J	K	Average	Item
$1.40	$0.90	$1.25	$0.70	$1.50	$0.90	$1.00	$1.01	1
6.00	3.00	3.00	4.00	3.00	6.00	4.00	4.05	2
1.25	1.00	.50	1.25	1.00	.75	2.00	1.30	3
1.50	2.00	2.10	1.95	1.90	1.95	3.00	1.94	4
10 00	13 40	7 50	12.00	8 75	8.25	15.00	10.28	5
15.00	13.40	15.00	14.50	16.50	18.00	16 00	14.30	6
.10	.10	.10	.15	.09	.15	.15	.11	7
.08	.06	.06	.04	045	.05	.045	.052	8
04	.04	.04	.035	.035	.05	.045	.038	9
.04	.05	.08	.08	.085	.03	04	.054	10
.50	1.00	.45	.40	.30	.75	1.00	.63	11
50	.50	.75	.45	.60	.75	.50	57	12
.09	.12	.15	.21	.20	.15	.15	.133	13
1.25	2 50	2.50	2.25	3.00	2.25	2.50	2.39	14
50.00	50.00	1.00	35.00	50.00	50.00	50.00	43.73	15
100 00	500.00	500 00	1.000 00	500 00	6.000 00	1.000 00	1.041 00	16
$148,745.90	$150,905.00	$155,855.90	$159,030.90	$165,232.50	$178,947.50	$182,495.00	....	..

Vernon, N. Y. B—Whiting-Turner Construction Co., Sexton Building, Baltimore, Md. C—Barzaghi-Vought
City E—Winston & Company, 290 Broadway, New York City F—King Bros., 45 Hardenbrook Ave., Jamaica,
L Guidone and Company, 131 East 23rd St., New York City I—Cummings Structural Concrete Company, 221
Hoffman Contracting Company, Inc., 51 Chambers St., New York City

TAB

CANVASS OF BIDS OPENED APRIL 14, 1914, FOR **Contract 86,** FOR TH
AQUEDUCT, IN THE BOROUGH

ITEM	DESCRIPTION	UNIT	QUANTITY	*A
1	Earth excavation and refilling	Cubic yard	42,000	$1.30
2	Rock excavation	" "	3,300	2.25
3	66-inch steel pipe, ½-inch plate	Linear foot	3,700	13.41
4	66-inch steel pipe, 7/16-inch plate	" "	8,500	12.35
5	Coating 66-inch steel pipe with mineral rubber pipe coating	" "	8,100	.40
6	Covering 66-inch steel pipe with one layer of burlap soaked in mineral rubber pipe coating	" "	3,000	.85
7	Covering 66-inch steel pipe with two layers of burlap soaked in mineral rubber pipe coating	" "	2,000	1.40
8	Coating 66-inch steel pipe with bitumastic solution and enamel	" "	3,000	2.30
9	Coating 66-inch steel pipe with three coats of bitumastic solution	" "	1,000	1.15
10	Painting 66-inch steel pipe with materials supplied by The City	Square yard	400	.12
11	Cast-iron pipe, straight hub-and-spigot	Ton	185	37.00
12	Cast-iron hub-and-spigot pipe specials	"	85	75.00
13	Cast-iron flanged pipe and flanged specials	"	20	110.00
14	Cast-iron valve-boxes, manhole heads and covers	"	25	45.00
15	Steel castings	Pound	10,500	.11
16	Caring for and setting metal-work furnished by The City	"	190,000	.02
17	48-inch to 66-inch Venturi meter	Meter	1	2,800.00
18	Structural and reinforcing steel	Pound	15,000	.05
19	Miscellaneous cast iron, wrought iron and steel	"	15,000	.05
20	Portland cement	Barrel	3,200	1.50
21	Concrete masonry under pavement or curb	Cubic yard	2,000	4.50
22	Concrete masonry as cradles for sewers or drains	" "	100	8.00
23	Brick and concrete masonry in chambers and sewers	" "	350	11.25
24	Changing water services 2-inch and smaller	Service	300	5.00
25	Crushed stone and gravel for drains	Cubic yard	15	3.00
26	Vitrified or cement pipe 3 to 8 inches in diameter	Linear foot	3,000	.50
27	Vitrified or cement pipe 9 to 18 inches in diameter	" "	1,500	1.25
28	Wood block pavement	Square yard	70	4.50
29	Granite block pavement	" "	220	1.00
30	Sheet asphalt pavement	" "	12,000	1.00
31	Flag sidewalks and cross-walks	" "	2,200	.50
32	Hexagonal asphalt block sidewalks	" "	100	4.50
33	Cement concrete sidewalks	Square foot	3,500	.18
34	Curb	Linear foot	370	.12
35	Board fence	" "	1,175	1.35
	Amounts of bids			$298,908.15

Time: 17 months Bond required: $110,000 *Awarded contract A—Beaver Engin
2 Wall St., New York City C—John J. Hart, Peekskill, N. Y. D—Booth & Flinn, Limited
New York City F—P. J. Carlin Construction Co., 1123 Broadway, New York City G—Mid
A. L. Guidone and Company filled out the prices in the form of contract and submitted t

17

NSTRUCTION OF PART OF QUEENS CONDUIT, A PORTION OF CATSKILL
ROOKLYN, NEW YORK CITY

B	C	D	E	F	G	AVERAGE	ITEM
$1.47	$1.94	$1.60	$2.00	$2.00	$2.00	$1.76	1
1.70	2.00	3.00	3.50	2.50	4.00	2.71	2
14.00	13.90	15.00	15.50	14.00	15.00	14.40	3
13.00	12.96	14.20	15.00	13.00	13.50	13.43	4
.35	.40	.35	.35	.50	.40	.39	5
.75	.83	.75	.80	.90	1.00	.84	6
1.25	1.40	1.25	1.45	1.50	1.40	1.38	7
2.31	.72	2.50	2.25	2.50	2.40	2.14	8
1.38	.82	1.40	1.15	1.50	1.20	1.23	9
.10	.12	.10	.10	.50	2.00	.43	10
30.00	35.00	45.00	40.00	50.00	35.00	38.86	11
70.00	90.00	100.00	75.00	100.00	100.00	87.14	12
90.00	80.00	100.00	70.00	120.00	100.00	95.71	13
45.00	60.00	75.00	50.00	50.00	80.00	57.86	14
.10	.12	.15	.12	.20	.15	.135	15
.01	.03	.05	.01	.05	.05	.03	16
00.00	2,500.00	2,500.00	2,800.00	2,800.00	3,000.00	2,628.57	17
.04	.06	.05	.03	.05	.05	.05	18
.05	.05	.07	.04	.05	.10	.06	19
1.60	1.50	1.50	1.50	2.00	1.80	1.63	20
3.00	4.26	4.00	4.25	5.00	5.00	4.29	21
5.00	7.00	6.00	8.50	6.00	8.00	6.93	22
10.00	12.00	10.00	12.00	12.00	10.00	11.04	23
5.00	5.00	3.50	12.00	1.00	10.00	5.93	24
2.00	3.00	3.00	3.00	2.00	2.50	2.64	25
.20	.50	.50	.40	.50	.40	.43	26
.60	1.25	1.00	.80	.75	.70	.91	27
2.50	1.50	3.00	2.25	2.00	4.00	2.82	28
1.50	1.50	1.50	.50	1.00	1.00	1.14	29
1.35	1.50	1.50	1.30	2.00	1.50	1.46	30
.90	.60	1.00	.90	1.00	1.00	.84	31
1.75	1.00	1.50	1.25	1.25	4.00	2.18	32
.20	.23	.20	.14	.20	.20	.19	33
.40	.30	.50	50	.50	.30	.37	34
2.30	.76	1.00	.85	2.00	3.50	1.68	35
,870.50	$334,367.00	$349,845.00	$363,951.25	$364,875.00	$372,361.00	......	..

and Contracting Company, 51 Chambers St., New York City B—P. J. Moranti, Inc.,
2 Forbes St., Pittsburg, Pa. E—Oscar Daniels Company, Room 3812 Woolworth Building,
H. Blake, 266 West 34th St., New York City
a bid

Canvass of Bids Opened May 12, 1914, for **Contract**

Item	Description	Unit	Quantity	*A
1	Excavation and refilling	Cubic yard	11,700	$1.15
2	Furnishing and laying straight hub-and-spigot cast-iron pipe	Ton	1,630	25.60
3	Furnishing and laying cast-iron hub-and-spigot pipe specials	"	90	66.00
4	Hauling and laying 48-inch cast-iron pipe	"	130	3.57
5	Cast-iron valve-boxes, manhole heads and covers	"	10	44.00
6	Caring for and setting metal-work furnished by The City	Pound	56,000	.02
7	Structural and reinforcing steel	"	3,600	.04
8	Miscellaneous cast iron, wrought iron and steel	"	2,700	.05
9	Portland cement	Barrel	630	1.75
10	Concrete masonry in pavement or curb foundations	Cubic yard	470	3.85
11	Concrete masonry as cradles for pipe sewers or drains	"	10	5.50
12	Brick and concrete masonry in chambers and sewers	"	70	13.00
13	Changing water services 2-inch and smaller	Service	30	3.00
14	Crushed stone and gravel for drains	Cubic yard	5	2.50
15	Vitrified or cement pipe 3 to 8 inches in diameter	Linear foot	200	.75
16	Vitrified or cement pipe 9 to 15 inches in diameter	"	150	1.00
17	Slag block pavement	Square yard	250	1.60
18	Granite block pavement	"	1,650	1.00
19	Macadam pavement	"	650	.40
20	Cobblestone gutter	"	150	.01
21	Curb	Linear foot	150	.01
22	Cement concrete sidewalks	Square foot	1,400	.12
	Amounts of bids			$70,186.60 $74,

Time: 7 months Bond required: $30,000 *Awarded contract A—Beaver Engineering and Co
Staten Island, N. Y. D—Soraci Contracting Company, 170 Broadway, New York City E—P. J. Mora
H—Riverdale Contracting Company, Inc., 37 East 28th St., New York City I—A. L. Guidone and Con
St., New York City L—Knight & DeMicco, Inc., 4441 Park Ave., The Bronx, New York City M—C

TABLE 18

THE CONSTRUCTION OF PART OF RICH
UGH OF RICHMOND, NEW YORK CITY

C	D	E	F	
$1.38	$1.50	$1.70	$1.80	
27.50	29.00	27.50	30.00	
59.00	70.00	80.00	70.00	
9.00	6.00	6.00	8.00	
59.00	60.00	50.00	45.00	
.03	.01	.02	.01	
.05	.05	.04	.05	
.05	.06	.06	.05	
1.50	1.20	1.70	.01	
4.00	3.50	5.00	.01	
8.00	4.00	7.00	5.00	
10.50	12.00	8.00	15.00	
5.00	1.00	3.50	5.00	
2.25	1.00	1.50	3.00	
.60	.20	.25	.50	
1.00	.40	.60	1.25	
2.50	1.00	1.50	3.91	
1.50	1.00	1.25	3.91	
.50	1.00	.50	.75	
.50	.30	.25	1.00	
.25	.25	.20	.50	
.20	.15	.20	.25	
[illegible].75	$79,000.50	$82,034.50	$88,680.00	$8[illegible]

ompany, 51 Chambers St., New York City B—F
Wall St., New York City F—Carfagno & Dragon
East 23rd St., New York City J—Hanover Con
eynolds, Inc., 1480 Broadway, New York City

Canvass of Bids Opened January 27, 1914, for **Contract 9**

Item	Description	Unit	Quantity	*A	B
1	Furnishing submarine pipe	Ton	3,800	$47.25	$65.00
2	Furnishing straight hub-and-spigot cast-iron pipe	"	300	26.60	40.00
3	Furnishing cast-iron hub-and-spigot pipe specials	"	35	61.25	80.00
4	36-inch Venturi meters	Meter	2	1,640.00	2,000.00
5	Submarine excavation	Cubic yard	600,000	.45	.60
6	Removing and replacing sea-wall	Lump sum	......	2,000.00	1,000.00
7	Laying submarine pipe-line	Linear foot	9,800	30.20	9.00
8	Submarine calking of pipe joints	Joint	200	20.00	50.00
9	General submarine calking of pipe-line	Lump sum	......	12,000.00	5,000.00
10	Air tests of submarine pipe-line	Test	10	500.00	1,000.00
11	Refilling over submarine pipe-line with materials from harbor bottom	Cubic yard	125,000	.30	.25
12	Refilling over submarine pipe-line with selected materials not from harbor bottom	"	125,000	.98	1.20
13	Earth excavation and refilling on land	"	2,200	1.87	5.00
14	Rock excavation on land	"	30	10.00	5.50
15	Laying hub-and-spigot cast-iron pipe and special pipe castings	Linear foot	950	3.50	2.50
16	Miscellaneous cast iron, wrought iron and steel	Pound	15,000	.08	.05
17	Caring for and setting metal-work furnished by The City	"	19,000	.05	.02
18	Portland cement	Barrel	200	2.00	2.00
19	Concrete masonry in pavement or gutter foundations	Cubic yard	20	10.00	7.00
20	Brick masonry and concrete masonry not included in Item 19	"	100	12.00	7.50
21	Vitrified or cement pipe	Linear foot	150	1.00	1.00
22	Crushed stone and gravel for drains	Cubic yard	10	2.50	2.00
23	Street pavement, sidewalks and cross-walks	Square yard	600	2.85	1.00
24	Piles for foundations placed between Station 6107 and Station 6196	Linear foot	10,000	1.00	4.50
25	Piles not included in Item 24	"	2,000	1.00	.50
26	Timber and umber	Mft.B.M.	25	75.00	65.00
27	Steel sheet piling	Pound	500,000	.04	.025
	For the additional cost of constructing a portion of the Narrows siphon on the alternative location shown on the diagram, Accession E627	Lump sum	......	7,500.00	5.00
	Amounts of bids	....	......	$996,863.75	$996,110.00

$1,

Time: 24 months Bond required: $400,000 *Awarded contract A—Merritt & Chapman Derrick & Broadway, New York City D—Michael J. Dady, 350 Fulton St., Brooklyn, N. Y. E—Morris & Cuming's D Inc., Rooms 8-15, Marine Building, Toledo, O. H—Holbrook, Cabot and Rollins Corporation and Geo. B. City K—The Phoenix Construction Company, 41 Park Row, New York City L—Patrick McGovern & Co.

TABLE 19

)R THE CONSTRUCTION OF THE I

	D	E	
60.00	$55.00	$48.00	
30.00	30.00	22.00	
70.00	67.00	48.00	
00.00	1,800.00	2,000.00	
.60	.49	.82	
00.00	2,000.00	1,000.00	
19.30	23.00	22.00	
60.00	70.00	30.00	
00.00	20,000.00	15,000.00	
00.00	300.00	150.00	
.20	1.35	.70	
.80	.21	.80	
1.25	3.00	1.25	
10.00	10.00	10.00	
3.00	2.50	1.25	
.065	.15	.05	
.03	.05	.025	
2.00	1.50	2.00	
10.00	6.00	8.00	
20.00	25.00	10.00	
1.00	1.50	1.00	
4.00	3.00	2.00	
1.25	1.50	2.00	
1.50	2.50	1.25	
.45	.75	.40	
00.00	80.00	60.00	
.04	.035	.04	
00.00	100,000.00	10,000.00	
75.00	**$1,130,895.00**	**$1,166,472.50**	**$1,**

ecking Company, 17 Battery Place, New
ping Co., 17 State St., New York City
y, 331 Madison Ave., New York City]
Madison Ave., New York City

Canvass of Bids Opened February 3, 1914, for **Contract 104**, for Fu
Valves, Pressure-Regulating Valves, Sluice-Gates and A

Item	Description	Unit	Quantity	*A	B
1	48-inch gate-valves, heavy-pressure type	Valve	6	$1,855.00	$1,900.00
2	48-inch gate-valves, low-pressure type	"	5	1,328.00	1,500.00
3	36-inch gate-valves	"	2	808.00	950.00
4	30-inch gate-valves	"	35	909.00	890.00
5	16-inch gate-valves with flanges	"	44	236.00	225.00
6	16-inch gate-valves with bell ends	"	2	260.00	225.00
7	10-inch gate-valves	"	4	99.00	95.00
8	10-inch angle gate-valve	"	1	162.00	120.00
9	8-inch gate-valves	"	3	47.00	21.00
10	6-inch gate-valves with flanges	"	32	19.00	15.00
11	6-inch gate-valves with bell ends	"	7	16.00	15.00
12	6-inch angle gate-valves	"	4	31.00	17.[illegible]
13	4-inch gate-valves	"	2	22.00	10.00
14	Drive shafting	Lump sum.	.....	750.00	900.00
15	48-inch controlling valves	Valve	2	3,884.00	4,500.00
16	36-inch controlling valve	"	1	2,888.00	3,000.00
17	20-inch flap valve	"	1	215.00	150.00
18	15-inch flap valves	"	3	83.00	85.00
19	12-inch flap valves	"	8	47.50	50.00
20	6-inch flap valves	"	2	16.50	16.00
21	16-inch pressure-regulating valves	"	3	310.00	325.00
22	5-foot by 5-foot sluice-gate	Gate	1	1,160.00	1,150.00
23	3-foot by 5-foot sluice-gates	"	2	534.00	[illegible]
24	30-inch by 42-inch sluice-gates	"	2	335.00	[illegible]
25	Operating stands for gate-valves	Stand	7	220.00	250.00
26	Operating stand for sluice-gate at Croton Lake siphon	"	1	342.00	225.00
27	Operating stands for sluice-gates at Silver Lake reservoir	"	4	419.00	300.00
28	16-inch circular sluice-gates	Gate	2	56.50	55.00
29	10-inch circular sluice-gates	"	5	37.00	25.00
30	Reduction gearing for 12-inch gate-valve	Set	1	132.00	35.00
31	Indicators and hand wheels for 16-inch gate-valves	"	8	61.50	16.00
32	Tide-gate	Gate	1	177.00	135.00
33	Special iron pipe castings	Pound	60,000	.04	.05
34	Miscellaneous bronze and copper	"	3,000	.45	.30
35	Miscellaneous iron and steel	"	5,000	.07	.06
36	Galvanizing	"	2,000	.02	.04
	Amounts of bids			[illegible]	[illegible]

Time: 60 weeks Bond required: $70,000 *Awarded contract A—Coffin Valve Company, Nepon
Pittsburgh, Pa. D—The Kennedy Valve Manufacturing Company, Elmira, N. Y. and 57 Beekman St.
Noonan & Company, 316 Dickinson St., Springfield, Mass. H—The Chapman Valve Manufacturing Co.
Co., Washington Ave. and Fifth St., Philadelphia, Pa.

LE 20

ELIVERING AND INSTALLING WHERE REQUIRED, G
CES FOR CITY AQUEDUCT AND CROTON LAKE SIPH

	D	E	F	G	
	$1,900.00	$2,620.00	$2,600.00	$2,641.50	$2,7
	1,700.00	1,980.00	1,930.00	2,048.00	1,7
	1,075.00	1,310.00	1,225.00	1,237.50	9
	1,100.00	1,270.00	1,150.00	1,263.00	1,5
	275.00	325.00	305.00	346.00	3
	275.00	325.00	305.00	346.00	3
	100.00	210.00	158.00	196.75	1
	150.00	210.00	199.00	225.00	1
	21.20	160.00	95.00	33.75	
	14.60	90.00	53.00	15.75	
	14.60	90.00	53.00	15.75	
	22.50	90.00	54.50	84.00	
	11.00	100.00	52.50	11.25	
	462.00	520.00	1,075.00	900.00	1,
	3,700.00	3,150.00	4,800.00	6,016.00	5,
	2,950.00	2,330.00	3,900.00	3,478.00	4,
	340.00	240.00	183.00	206.00	
	125.00	150.00	95.00	106.00	
	68.00	80.00	62.00	69.75	
	98.70	60.00	53.00	59.50	
	442.75	375.00	603.00	450.00	
	1,437.00	1,350.00	1,300.00	1,350.00	1
	582.70	640.00	550.00	618.00	
	347.00	400.00	392.00	441.00	
	380.00	180.00	420.00	472.00	
	380.00	260.00	510.00	573.00	
	715.00	480.00	645.00	725.00	
	34.00	120.00	80.00	67.50	
	20.00	100.00	61.00	50.00	
	350.00	110.00	115.00	130.00	
	42.50	30.00	83.00	62.00	
	250.00	150.00	220.00	248.00	
5	.06	.0563	.09	.05	
	.28	.40	.40	.42	
	.08	.10	.12	.09	
	.03	.05	.05	.05	
	$103,296.05	$118,253.00	$120,918.00	$126,046.00	$13

s. B—The A. P. Smith Manufacturing Company, East Orange,
E—Bethlehem Steel Products Company, South Bethlehem, Pa
, Springfield, Mass. I—J. Edward Ogden Company, 147 Ceda

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TABLE 21

CANVASS OF BIDS OPENED APRIL 21, 1914, FOR **Contract 118,** FOR THE CONSTRUCTION OF ELEVEN SUPERSTRUCTURES ALONG THE LINE OF CATSKILL AQUEDUCT, IN THE TOWNS OF PHILLIPSTOWN, PUTNAM COUNTY, AND CORTLANDT, YORKTOWN AND MT. PLEASANT, WESTCHESTER COUNTY, NEW YORK

Item	Description	Unit	Quantity	*A	B	C	D	E	F	G	Average
1	Gray Portland cement	Barrel	2,000	$1.75	$2.00	$2.10	$2.10	$2.00	$2.15	$2.50	$2.09
2	White Portland cement	"	850	3.50	3.50	3.76	4.00	3.40	3.55	4.50	3.74
3	Sprout Brook north siphon chamber, exclusive of Items 1 and 2	Lump sum.	....	9,500.00	10,697.00	11,800.00	11,227.00	12,300.00	12,734.00	14,889.00	11,878.14
4	Sprout Brook south siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,697.00	11,900.00	11,227.00	12,300.00	12,734.00	13,989.00	11,763.86
5	Peekskill north siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,476.00	11,800.00	11,227.00	12,400.00	12,734.00	13,489.00	11,660.86
6	Peekskill south siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,259.00	10,800.00	11,227.00	11,800.00	12,734.00	13,489.00	11,401.29
7	Hunters Brook north siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,420.00	11,150.00	11,227.00	11,400.00	13,234.00	12,489.00	11,345.71
8	Hunters Brook south siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,420.00	11,150.00	11,227.00	11,400.00	13,234.00	12,489.00	11,345.71
9	Turkey Mountain north siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,420.00	11,150.00	11,227.00	11,400.00	13,000.00	12,489.00	11,312.29
10	Turkey Mountain south siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	10,420.00	11,150.00	11,227.00	11,400.00	13,000.00	12,489.00	11,312.29
11	Croton gaging chamber, exclusive of Items 1 and 2	" "	....	8,900.00	5,138.00	6,900.00	7,914.00	7,400.00	8,146.00	7,777.00	7,453.57
12	Harlem Railroad north siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	9,813.00	11,150.00	11,227.00	11,300.00	12,700.00	12,489.00	11,168.43
13	Harlem Railroad south siphon chamber, exclusive of Items 1 and 2	" "	....	9,500.00	9,596.00	10,800.00	11,227.00	11,200.00	12,700.00	12,489.00	11,073.14
	Amounts of bids			**$110,375.00**	**$115,331.00**	**$127,146.00**	**$127,784.00**	**$131,100.00**	**$144,267.50**	**$147,392.00**	....

Time: 24 months Bond required: $50,000 *Awarded contract **A**—A. L. Guidone and Company, 131 East 23rd St., New York City **B**—The Torrington Building Co., Inc., Poughkeepsie, N. Y. **C**—Hermans, Madden & Company, 103 Park Ave., New York City **D**—Joseph E. Butterworth, 5 Colden Ave., White Plains, N. Y. **E**—Charles Meads & Co., 165 Broadway, New York City **F**—William H. Egan, 147 East 125th St., New York City **G**—Thomas G. Carlin, Inc., 93 Garfield Place, Brooklyn, N. Y.

TABLE 22

Canvass of Bids Opened June 2, 1914, for **Contract 124**, for the Construction of Nine Superstructures for Ashokan Upper and Lower Gate, Screen and Gaging Chambers, and Esopus and Tongore Siphon Chambers, and of the Balustrades and Cartouches on Ashokan Bridge, in the Town of Olive, Ulster County, New York

Item	Description	Unit	Quantity	*A	B	C	D	E	F	G	Average
1	Gray Portland cement	Barrel	4,500	$2.15	$6.00	$2.00	$2.50	$2.00	$2.47	$2.00	$2.73
2	White Portland cement	"	650	3.80	7.50	4.00	3.50	3.60	4.21	4.00	4.37
3	Miscellaneous excavation	Cubic yard	300	.85	1.00	1.33⅓	1.00	1.00	.72	3.00	1.27
4	Ashokan Upper gate-chamber east superstructure, retaining-walls and balustrade, exclusive of Items 1, 2 and 3	Lump sum.	....	52,385.00	50,000.00	57,000.00	56,325.00	60,434.00	53,500.00	58,612.00	55,465.14
5	Ashokan Upper gate-chamber west superstructure, retaining-walls and balustrade, exclusive of Items 1, 2 and 3	"	....	51,950.00	50,000.00	56,500.00	56,325.00	59,627.00	54,000.00	58,612.00	55,287.71
6	Ashokan Lower gate-chamber superstructure and retaining-walls, exclusive of Items 1, 2, 3 and 14	" "	....	73,300.00	69,000.00	76,000.00	76,991.00	82,879.00	76,000.00	89,051.00	77,603.00
7	Ashokan Screen chamber superstructure, exclusive of Items 1, 2 and 3	" "	....	71,400.00	67,000.00	76,000.00	81,924.00	80,374.00	84,000.00	87,000.00	78,242.57
8	Ashokan Gaging chamber superstructure, exclusive of Items 1, 2 and 3	" "	....	9,200.00	8,600.00	8,500.00	9,641.00	9,171.00	12,300.00	11,559.00	9,853.00
9	Esopus north siphon chamber superstructure, exclusive of Items 1, 2 and 3	" "	....	15,300.00	14,000.00	14,500.00	17,134.00	15,507.00	18,300.00	17,395.00	16,019.43
10	Esopus south siphon chamber superstructure, exclusive of Items 1, 2 and 3	" "	....	15,300.00	14,000.00	14,500.00	17.134.00	15,507.00	18,300.00	17,395.00	16,019.43
11	Tongore north siphon chamber superstructure, exclusive of Items 1, 2 and 3	" "	....	10,800.00	11,000.00	16,000.00	12,743.00	11,627.00	14,400.00	12,477.00	12,721.00
12	Tongore south siphon chamber superstructure, exclusive of Items 1, 2 and 3	" "	....	10,800.00	11,000.00	16,000.00	12,743.00	11,627.00	21,000.00	12,477.00	13,663.86
13	Balustrades and cartouches on Ashokan bridge, exclusive of Items 1, 2 and 3	" "	....	20,500.00	21,000.00	24,000.00	19,573.00	24,312.00	21,000.00	21,671.00	21,722.29
14	Office structures, except toilet-room, in Ashokan Lower gate-chamber, exclusive of Items 1, 2 and 3	" "	....	2,200.00	5,000.00	3,500.00	4,113.00	3,639.00	7,800.00	3,669.00	4,274.43
	Amounts of bids			**$345,535.00**	**$352,775.00**	**$374,500.00**	**$378,471.00**	**$386,344.00**	**$394,667.50**	**$402,418.00**	....

Time: 28 months. Bond required: $140,000. *Awarded contract. A—Michael Staub, 14 Ward Ave., Mamaroneck, N. Y. B—W. F. Plass & Bro., 145 West 18th St., New York City. C—The Marble Arch Co., 216th St. and Broadway, New York City. D—William H. Egan, 147 East 125th St., New York City. E—W. P. Seaver, 322 Fifth Ave., New York City. F—Midtown Contracting Company, 148 West 30th St., New York City. G—A. L. Guidone and Company, 131 East 23rd St., New York City.

TABLE 23

Canvass of Bids Opened July 14, 1914, for Contract 145, for Roofing, With Reinforced Concrete Tiles, Various Superstructures Along the Line of Catskill Aqueduct

Item	Description	Unit	Quantity	*A
1	Ashokan Upper gate-chamber (east)......	Lump sum...	....	$4,182.00
2	Ashokan Upper gate-chamber (west).....	" ...	....	4,182.00
3	Ashokan Lower gate-chamber............	" ...	....	7,833.00
4	Ashokan Screen chamber................	" ...	....	7,249.00
5	Ashokan Gaging chamber...............	" ...	....	1,075.00
6	Esopus North Siphon chamber...........	" ...	....	1,300.00
7	Esopus South Siphon chamber...........	" ...	....	1,300.00
8	Tongore North Siphon chamber..........	" ...	....	1,300.00
9	Tongore South Siphon chamber..........	" ...	....	1,300.00
10	Peak Gaging chamber..................	" ...	....	1,075.00
11	Rondout Drainage chamber.............	" ...	....	2,859.00
12	Wallkill Drainage chamber.............	" ...	....	2,859.00
13	Wallkill Gaging chamber..............	" ...	....	1,075.00
14	Wallkill Blow-off chamber...............	" ...	....	1,032.00
15	Washington Square North Siphon chamber	" ...	....	1,300.00
16	Washington Square South Siphon chamber	" ...	....	1,300.00
17	Hudson Drainage chamber..............	" ...	....	3,886.00
18	Breakneck Gaging chamber.............	" ...	....	1,075.00
19	Foundry Brook South Siphon chamber....	" ...	....	1,300.00
20	Indian Brook North Siphon chamber.....	" ...	....	1,300.00
21	Indian Brook South Siphon chamber.....	" ...	....	1,300.00
22	Sprout Brook North Siphon chamber.....	" ...	....	1,300.00
23	Sprout Brook South Siphon chamber.....	" ...	....	1,500.00
24	Peekskill North Siphon chamber.........	" ...	....	1,300.00
25	Peekskill South Siphon chamber.........	" ...	....	1,300.00
26	Hunters Brook North Siphon chamber....	" ...	....	1,300.00
27	Hunters Brook South Siphon chamber....	" ...	....	1,300.00
28	Turkey Mountain North Siphon chamber.	" ...	....	1,300.00
29	Turkey Mountain South Siphon chamber..	" ...	....	1,300.00
30	Croton Downtake chamber.............	" ...	....	4,295.00
31	Croton Gaging chamber................	" ...	....	1,075.00
32	Harlem Railroad North Siphon chamber..	" ...	....	1,300.00
33	Harlem Railroad South Siphon chamber...	" ...	....	1,300.00
34	Kensico Influent chamber...............	" ...	....	2,352.00
35	Kensico Upper Effluent chamber.........	" ...	....	3,285.00
36	Kensico Lower Effluent chamber.........	" ...	....	8,266.00
37	Kensico Screen chamber...............	" ...	....	2,810.00
38	Kensico North Siphon chamber..........	" ...	....	1,300.00
39	Kensico South Siphon chamber..........	" ...	....	1,300.00
40	Elmsford North Siphon chamber.........	" ...	....	1,300.00
41	Elmsford South Siphon chamber.........	" ...	....	1,300.00
42	Fort Hill North Siphon chamber.........	" ...	....	1,300.00
43	Fort Hill South Siphon chamber.........	" ...	....	1,300.00
44	Bryn Mawr North Siphon chamber.......	" ...	....	1,300.00
45	Hill View Uptake chamber..............	" ..	....	6,648.00
46	Hill View Downtake chamber............	" ...	....	8,034.00
47	Furnishing and erecting ventilating tiles wherever ordered instead of pan tiles...	**Tile.......	180	10.00
	Amount of bid..			$110,947.00

Time: 36 months Bond required: $40,000 *Awarded contract **Price per ventilating tile is in addition to the lump sum stipulated for each building on which the ventilating tiles are placed A—American Cement Tile Mfg. Co., 2223 Oliver Building, Pittsburg, Pa.

TABLE 24

CANVASS OF BIDS OPENED JUNE 9, 1914, FOR **Contract 148,** FOR THE CONSTRUCTION OF A PORTION OF THE CATSKILL AQUEDUCT TELEPHONE SYSTEM, BETWEEN CROTON LAKE AND NEW YORK CITY, NEW YORK

ITEM	DESCRIPTION	UNIT	QUANTITY	*A	B	C	AVERAGE
1	25-foot wooden poles	Pole	130	$7.08	$12.00	$9.32	$9.47
2	35-foot wooden poles	"	15	9.89	15.00	12.74	12.54
3	40-foot wooden poles	"	15	13.25	20.00	16.60	16.62
4	Setting wooden poles in solid rock at additional price	"	60	5.00	6.00	17.50	9.50
5	Moving existing wooden poles	"	100	7.46	15.00	7.75	10.07
6	Wire guys	Guy	225	6.50	10.00	7.08	7.86
7	4-pin cross-arms	Cross-arm	300	1.56	1.50	1.95	1.67
8	6-pin cross-arms	"	1,500	1.93	2.00	2.16	2.03
9	8-pin cross-arms	"	250	2.30	2.25	2.38	2.31
10	10-pin cross-arms	"	110	2.66	2.50	2.70	2.62
11	Insulators	Insulator	4,700	.10	.026	.05½	.06
12	Bare copper wire	Pound	16,000	.20	.23	.23	.22
13	Brackets in aqueduct tunnels	Bracket	240	7.40	8.00	1,285.00	433.47
14	Aqueduct tunnel cable entrances	Entrance	2	163.00	80.00	125.00	122.67
15	Station protection	Station	3	71.00	83.00	83.00	79.00
16	Switchboard protection	Lump sum	......	98.00	100.00	94.00	97.33
17	Pole numbering	" "	......	1,491.00	300.00	275.00	688.67
18	Transpositions	Transposition	125	1.00	.70	1.90	1.20
19	Clearing and trimming of trees	Man-day	150	3.00	3.00	4.00	3.33
	Amounts of bids			**$16,155.60**	**$17,551.20**	**$323,822.87**	....

Time: 2 months Bond required: $12,000 *Awarded contract A—Lord Electric Co., 105 West 40th St., New York City B—New York Telephone Company, 15 Dey St., New York City C—Lewis H. Woods, 2355 Jerome Ave., The Bronx, New York City

TABLE 25

CANVASS OF BIDS OPENED APRIL 3, 1914, FOR **Contract 156,** FOR FURNISHING, DELIVERING AND PLANTING TREE TRANSPLANTS AT ASHOKAN AND KENSICO RESERVOIRS, IN ULSTER AND WESTCHESTER COUNTIES, NEW YORK

ITEM	DESCRIPTION	UNIT	QUANTITY	*A	B	C	D	E	F	AVERAGE
1	Furnishing tree transplants for, and planting at Ashokan reservoir during the planting season of 1914 with at least four varieties of tree transplants, selected in accordance with Section 6 of the specifications........	Acre	200	$26.00	$47.50	$62.00	$71.00	$100.62	$141.51	$74.77
2	Furnishing tree transplants for, and planting at Kensico reservoir during the planting season of 1914 with at least four varieties of tree transplants, selected in accordance with Section 6 of the specifications........	"	200	26.00	47.50	60.00	68.00	120.47	136.51	76.41
3	Furnishing tree transplants for, and planting at Ashokan reservoir during the planting season of 1915 with at least four varieties of tree transplants, selected in accordance with Section 6 of the specifications.........	"	200	26.00	47.50	44.00	71.00	100.34	141.51	71.72
4	Furnishing tree transplants for, and planting at Kensico reservoir during the planting season of 1915 with at least four varieties of tree transplants, selected in accordance with Section 6 of the specifications.........	"	200	26.00	47.50	43.00	68.00	120.19	136.51	73.53
5	Furnishing tree transplants for, and planting at Ashokan reservoir during the planting season of 1916 with at least four varieties of tree transplants, selected in accordance with Section 6 of the specifications.........	"	100	26.00	47.50	38.00	71.00	100.90	141.51	70.82
6	Furnishing tree transplants for, and planting at Kensico reservoir during the planting season of 1916 with at least four varieties of tree transplants, selected in accordance with Section 6 of the specifications.........	"	100	26.00	47.50	36.00	68.00	120.75	136.51	72.46
	Amounts of bids..................	....	....	**$26,000.00**	**$47,500.00**	**$49,200.00**	**$69,500.00**	**$110,489.00**	**$139,010.00**	.....

Time: December 15, 1916 Bond required: 35 per cent. of contract *Awarded contract A—The North-Eastern Forestry Co., Cheshire, Conn. and Franklin Forestry Company, 89 State St., Boston, Mass. B—Wadley and Smythe, 491 Fifth Ave., New York City C—Abner M. Harper, Inc., 56 Second St., Newburg, N. Y. D—International Nurseries, Inc., 1905 West Farms Road, New York City E—Peter A. Keene, 949 Broadway, New York City and Edmund K. Brown, 13 Park Row, New York City F—Siebrecht & Son, New Rochelle, N. Y. and 619 Fifth Ave., New York City

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CANVASS OF BIDS OPENED NOVEMBER 10, 1914, FOR **Contract 160,** FOR THE
CATSKILL AQUEDUCT, IN THE TOWN

ITEM	DESCRIPTION	UNIT	QUANTITY	*A	B
1	Excavation in shafts	Cubic yard	5,000	$15.00	$15.00
2	Excavation of tunnel	"	9,600	12.00	14.00
3	Additional trimming in shaft and tunnel	Square yard	200	3.00	6.00
4	Care and closing of Shaft 7	Lump sum	......	20,100.00	500.00
5	Furnishing structural steel roof support	Pound	15,000	.025	.035
6	Erecting structural steel roof support	"	50,000	.02	.02
7	Temporary timbering	M ft. B. M.	10	40.00	60.00
8	Pumping from shafts and tunnel	Million foot-gallons	150,000	.12	.20
9	Drainage channels for shafts and tunnel	Linear foot of shaft and tunnel	1,370	.50	2.00
10	Portland cement	Barrel	15,000	2.50	1.40
11	Forms for masonry lining in shaft and tunnel	Linear foot of forms	1,512	10.00	5.00
12	Concrete masonry in shafts	Cubic yard	2,600	7.00	10.50
13	Concrete masonry in tunnel	"	4,700	8.00	11.00
14	Excess concrete masonry	"	400	3.00	3.00
15	Dry packing in tunnel	"	100	2.00	2.00
16	Steel pipe for grouting, etc.	Linear foot	1,500	.20	.25
17	Miscellaneous plant and equipment for grouting	Lump sum	......	1,000.00	1,000.00
18	Making connections of grouting machines to grout pipes	Connection	400	1.00	2.00
19	Sand for grout	Ton	200	1.50	2.00
20	Mixing and placing grout	Cubic yard	400	2.00	10.00
21	Furnishing and erecting steel castings	Pound	11,000	.08	.10
22	Bronze access door and frame	"	8,000	.80	.60
23	Structural steel interlining	"	50,000	.08	.08
24	Drilling 1¼-inch or smaller holes in rock or masonry	Linear foot	100	.40	.30
25	Drilling 1¾-inch to 2½-inch holes in rock or masonry	"	400	.50	.35
26	Pointing and cleaning existing surfaces of concrete	Square foot	5,000	.15	.12
27	Miscellaneous cast iron, wrought iron and rolled steel	Pound	10,000	.06	.08
28	Galvanizing	"	4,000	.05	.03
29	Bronze pipe and miscellaneous bronze	"	4,000	1.00	.60
30	Timber and lumber	M ft. B. M.	10	40.00	60.00
31	Vitrified pipe	Linear foot	200	1.00	.75
32	Dry rubble masonry and paving	Cubic yard	100	2.00	3.50
33	Rubble masonry and paving in mortar	"	100	3.00	4.00
34	Vent hole in Shaft 8 plug	Lump sum	......	800.00	300.00
35	Office for engineers	"	......	1,250.00	750.00
36	Removing and replacing electric power and telephone lines	Pole	10	15.00	15.00
37	Removing hoist	Lump sum	......	25.00	100.00
38	Cleaning up	"	......	1.00	2,500.00
39	Foremen (for stopping cracks in shaft and tunnel)	Man-day	50	7.00	6.00
40	Drill-runners, calkers, riggers, and other skilled men (for stopping cracks in shaft and tunnel)	"	150	4.50	5.00
41	Helpers and laborers (for stopping cracks in shaft and tunnel)	"	150	3.50	3.00
	Amounts of bids			[illegible]	[illegible]

Time: 15 months Bond required: $140,000 *Awarded contract A—Oscar Daniels Company, 233 Broad Van Cortlandt Park, New York City B—Pittsburg Contracting Company, 17 Battery Place, New York City Geo. B. Fry, 331 Madison Ave., New York City G—The Snare & Triest Co., 233 Broadway, New York City Building, Pittsburg, Pa. J—Smith, Hauser & MacIsaac, Inc., 18 East 41st St., New York City

ICTION OF THE MOODNA SIPHON SUPPLEMENTARY SHAFT AND TUNNEL OF THE WALL, ORANGE COUNTY, NEW YORK

D	E	F	G	H	I	J	Average	Item
$17.00	$25.00	$27.55	$18.00	$22.00	$20.00	$35.00	$21.39	1
13.00	14.50	10.80	13.00	16.00	16.25	20.00	14.15	2
2.00	3.00	2.00	8.00	2.00	3.35	10.00	4.33	3
100.00	500.00	300.00	1,500.00	2,000.00	700.00	2,500.00	2,870.00	4
.07	.03	.01	.04	.02	.04	.035	.033	5
.07	.02	.02	.02	.02	.04	.05	.029	6
70.00	60.00	70.00	80.00	80.00	70.00	150.00	74.00	7
.35	.10	.20	.35	.10	.40	.60	.265	8
1.50	1.00	2.50	1.50	12.00	2.00	3.00	2.85	9
1.55	1.30	1.50	1.50	1.75	2.10	2.00	1.71	10
6.00	4.25	10.50	8.00	12.00	8.00	12.00	8.77	11
8.00	8.00	11.43	10.50	12.00	10.50	11.00	9.84	12
8.00	8.00	7.38	10.00	6.00	9.75	14.00	9.11	13
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	14
2.00	2.00	1.00	3.50	3.00	4.00	8.00	2.95	15
.25	.10	.50	.30	.30	.35	1.00	.345	16
2,500.00	5,000.00	500.00	2,500.00	2,500.00	1,000.00	2,000.00	1,950.00	17
.50	1.00	1.50	2.50	3.00	1.50	2.50	1.65	18
3.00	1.25	1.10	2.50	3.00	3.00	3.00	2.33	19
3.00	4.00	6.00	8.00	9.00	12.00	20.00	8.10	20
.10	.10	.12	.09	.08	.09	.15	.103	21
.60	.50	.70	.80	.60	.70	.60	.65	22
.10	.10	.09	.06	.10	.07	.15	.093	23
.30	.40	1.00	2.00	.50	.40	2.00	.77	24
.35	.50	2.00	2.50	.60	.60	2.50	1.05	25
.25	.05	.25	.30	.10	.20	.50	.207	26
.07	.05	.075	.05	.07	.05	.12	.069	27
.05	.02	.02	.03	.03	.05	.10	.04	28
.50	.50	.80	.80	.75	.60	1.00	.715	29
70.00	50.00	70.00	80.00	60.00	70.00	150.00	71.00	30
.80	.50	1.00	.60	2.50	1.00	3.00	1.26	31
3.00	3.00	2.00	4.00	3.50	4.00	15.00	4.30	32
5.00	4.00	4.00	5.00	4.50	5.50	17.00	5.60	33
600.00	500.00	250.00	500.00	600.00	1,500.00	1,500.00	680.00	34
1,500.00	500.00	1,000.00	1,200.00	1,000.00	1,000.00	2,500.00	1,130.00	35
10.00	10.00	5.00	30.00	50.00	100.00	25.00	28.00	36
100.00	50.00	20.00	200.00	100.00	200.00	250.00	107.00	37
1,000.00	1,000.00	1,500.00	1,000.00	5,000.00	500.00	1,500.00	1,450.10	38
10.00	6.00	6.00	6.00	8.00	8.00	6.00	7.10	39
6.00	4.00	4.00	5.00	5.00	4.50	5.00	4.70	40
3.50	3.00	3.00	3.00	2.50	2.50	4.00	3.05	41
$389,207.00	$394,816.00	$409,225.00	$416,281.00	$439,000.00	$471,226.00	$663,979.00	....	...

w York City B—The T. A. Gillespie Company, 50 Church St., New York City C—Mason and Hanger Company
Cogan Company, Contractors, 233 Broadway, New York City F—Holbrook, Cabot and Rollins Corporation and
mon Contracting Company, 30 East 42nd St., New York City I—The Dravo Contracting Company, Diamond Ban

TAB

Canvass of Bids Opened December 8,

Item	Description	Unit
1	Composition, 10-point, with side-notes	Page
2	Composition, 10-point, without side-notes	"
3	Composition, 8-point, without side-notes	"
4	Composition, 6-point, without side-notes	"
5	Tabulated composition, 8-point, 3-column	"
6	Tabulated composition, 8-point, 4-column and over	"
7	Tabulated composition, 6-point, 3-column	"
8	Tabulated composition, 6-point, 4-column and over	"
9	Alterations (composition, Items 1 to 8)	Line
10	Paper and presswork, editions of 150 copies, 8⅝ inches by 10⅞ inches, Grade A	Page
11	Paper and presswork, editions of 300 copies, 8⅝ inches by 10⅞ inches, Grade B	"
12	Paper and presswork, editions of 150 copies, 5 inches by 8 inches, Grade B	"
13	Paper and presswork, editions of 150 copies, 5⅞ inches by 8⅞ inches, Grade C	"
14	Paper and presswork, editions of 120 copies, 5⅞ inches by 8⅞ inches, Grade C	"
15	Paper and presswork, editions of 1,000 copies, 6 inches by 9 inches, Grade D	"
16	Paper and presswork, editions of 3,000 copies, 6 inches by 9 inches, Grade D	"
17	Paper and presswork, from half-tone plates, 1,000 sheets from each plate	Plate
18	Paper and presswork, 1,000 sheets of each insert	Leaf
19	Paper and presswork, 3,000 sheets of each insert	"
20	Printing titles on lithographs, editions of 300 sheets	Edition
21	Printing titles on lithographs, editions of 150 sheets	"
22	Folding	M folds
23	Binding in paper, stapled editions of 100 pamphlets, 8⅝ inches by 10⅞ inches, Grade A	Edition
24	Binding in cloth, sewed editions of 50 pamphlets, 8⅝ inches by 10⅞ inches, Grades A and B	"
25	Binding in paper, stapled editions of 250 pamphlets, 8⅝ inches by 10⅞ inches, Grade B	"
26	Binding in paper, sewed editions of 150 pamphlets, 5 inches by 8 inches, Grade B	"
27	Binding in paper, stapled editions of 100 pamphlets of lithographs, 8⅝ inches by 10⅞ inches, Grade A	"
28	Binding in cloth, sewed editions of 50 pamphlets of lithographs, 8⅝ inches by 10⅞ inches, Grades A and B	"
29	Binding in paper, stapled editions of 250 pamphlets of lithographs, 8⅝ inches by 10⅞ inches, Grade B	"
30	Binding in cloth, sewed editions of 120 sets of pamphlets, 5⅞ inches by 8⅞ inches, Grade C	"
31	Binding in cloth, sewed editions of 1,000 pamphlets, 6 inches by 9 inches, Grade D	"
32	Binding in paper, sewed editions of 1,000 pamphlets, 6 inches by 9 inches, Grade D	"
33	Binding in paper, sewed editions of 2,000 pamphlets, 6 inches by 9 inches, Grade D	"
34	Wire stitching uncovered pamphlets	C pamphle
35	Printing envelopes, editions of 50, about 9 inches by 12 inches	Edition
36	Furnishing and printing box envelopes, editions of 1,000, about 6 inches by 9 inches	"
37	Electrotyping	Square inc
38	Per cent. extra, account of rush work, as follows:	
	Item 1	Page
	Item 2	"
	Item 3	"
	Item 4	"
39	Per cent. extra, account of rush work, as follows:	
	Item 9	Line
40	Per cent. extra, account of rush work, as follows:	
	Item 10	Page
	Item 11	"
	Item 12	"
	Item 20	Edition
	Item 21	"
	Item 22	M folds
41	Per cent. extra, account of rush work, as follows:	
	Item 23	Edition
	Item 24	"
	Item 25	"
	Item 26	"
	Item 27	"
	Item 28	"
	Item 29	"
	Amounts of bids	

Bond required: 35 per cent. of contract *Awarded contract A—The J. W. Pratt Company, 52 Du and Binding Co., 201 East 12th St., New York City D—M. B. Brown Printing & Binding Co., 41 Chambe Company, 51 Vesey St., New York City

27

4, FOR **Contract AF**, FOR PRINTING

ANTITY	*A	B	C	D	E	F	AVERAGE	ITEM
1,850	$0.98	$0.95	$0.88	$0.97	$1.10	$1.10	$0.997	1
900	.78	.75	.74	.74	.95	.95	.818	2
1,800	1.00	.98	.98	1.00	1.25	1.25	1.08	3
60	1.96	1.84	1.95	2.00	2.00	2.00	1.96	4
1,500	1.42	1.37	1.40	1.40	1.75	2.15	1.58	5
150	1.75	1.78	1.71	1.75	2.00	2.25	1.87	6
20	2.94	2.75	2.95	2.90	3.10	3.10	2.96	7
500	3.90	3.49	3.40	3.90	3.80	4.00	3.75	8
5,000	.04	.04	.045	.05	.05	.05	.046	9
1,600	.37	.35	.43	.40	.45	.40	.40	10
600	.40	.50	.53	.50	.55	.55	.505	11
1,000	.24	.24	.29	.30	.32	.27	.277	12
2,100	.28	.25	.29	.30	.30	.30	.287	13
1,200	.25	.23	.27	.25	.28	.28	.26	14
100	.60	.67	.82	.70	.75	.70	.707	15
800	1.08	1.65	1.58	1.40	1.90	1.65	1.54	16
40	2.00	1.75	2.85	2.50	2.65	2.50	2.37	17
10	1.90	1.75	2.00	2.00	2.10	2.00	1.96	18
300	4.00	4.25	4.50	3.90	4.60	4.50	4.29	19
120	.88	.90	.92	.90	.93	.90	.905	20
200	.60	.68	.85	.74	.90	.75	.753	21
950	.29	.20	.26	.29	.27	.25	.26	22
20	11.00	9.25	10.25	10.00	11.50	15.00	11.17	23
30	12.50	11.25	12.25	12.25	13.25	13.00	12.42	24
10	9.00	10.15	10.50	10.00	11.50	11.00	10.36	25
5	6.75	6.00	6.50	6.50	7.50	7.00	6.71	26
10	7.00	7.00	12.50	11.00	11.00	11.00	9.92	27
10	11.50	11.00	11.25	10.00	12.00	11.50	11.21	28
10	11.00	10.50	11.50	11.00	12.50	12.00	11.42	29
4	20.00	22.00	26.50	19.00	40.00	50.00	29.58	30
2	140.00	145.00	143.70	170.00	180.00	160.00	156.45	31
5	20.00	45.00	47.50	48.00	52.00	60.00	45.42	32
3	96.00	120.00	95.00	90.00	97.50	110.00	101.42	33
300	.15	.13	.15	.15	.20	.30	.18	34
30	1.47	1.20	1.25	1.50	1.45	1.50	1.39	35
6	18.00	18.00	19.25	17.00	20.00	18.00	18.37	36
1,200	.04	.02	.02	.05	.0375	.025	.032	37
....	20%	20%	20%	20%	25%	30%	22½%	38
700	.196	.19	.176	.194	.275	.33	......	..
150	.156	.15	.148	.148	.2375	.285	......	..
10	.20	.196	.196	.20	.3125	.375	......	..
10	.392	.368	.39	.40	.50	.60	......	..
......	40%	20%	50%	30%	40%	40%	36⅔%	39
6,000	.016	.008	.0225	.015	.02	.02	......	..
....	20%	20%	20%	20%	20%	10%	18⅓%	40
500	.074	.07	.086	.08	.09	.04	......	..
300	.08	.10	.106	.10	.11	.055	......	..
150	.048	.048	.058	.06	.064	.027	......	..
30	.176	.18	.184	.18	.186	.09	......	..
80	.12	.136	.17	.148	.18	.075	......	..
50	.058	.04	.052	.058	.054	.025	......	..
....	20%	20%	20%	20%	20%	20%	20%	41
10	2.20	1.85	2.05	2.00	2.30	3.00	......	..
5	2.50	2.25	2.45	2.45	2.65	2.60	......	..
5	1.80	2.03	2.10	2.00	2.30	2.20	......	..
1	1.35	1.20	1.30	1.30	1.50	1.40	......	..
1	1.40	1.40	2.50	2.20	2.20	2.20	......	..
5	2.30	2.20	2.25	2.00	2.40	2.30	......	..
5	2.20	2.10	2.30	2.20	2.50	2.40	......	..
.....	$16,942.10	$16,986.02	$17,663.58	$17,800.39	$20,401.59	$20,534.10	......	..

t., New York City B—T. A. O'Keefe, 65 Park St., New York City C—The Trow Directory Printing
, New York City E—Clarence S. Nathan, 241-245 West 37th St., New York City F—Lecouver Press

CONTRACT	PERIOD COVERED BY REPORTS WEEKS	AVERAGE NUMBER OF CAMP INMATES	AVERAGE NUMBER OF MEN LIVING OUTSIDE CAMPS	*CASES TREATED		Ty
				Surgical	Medical	
2	35	...	57.6	...	...	
3, 10	52	2,548.9	...	8,052	10,850	
9	52	642.5	712.3	455	5,475	
30	51	276.6	90.2	60	41	
49	4	...	2.0	...	...	
53	31	...	27.2	1	...	
54	44	...	10.3	...	...	
55	21	...	131.0	17	...	
60	40	...	85.9	7	...	
63	52	...	292.9	206	...	
65	52	...	433.8	139	...	
66	52	...	112.4	61	...	
67	52	...	371.2	...	...	
72	40	90.2	50.1	1	...	
76	10	82.7	...	2	...	
79	52	...	42.7	4	...	
86	30	...	152.7	12	...	
88	25	...	51.2	6	...	
89	50	151.8	67.2	24	5	
90	12	45.0	15.2	29	37	
99	39	...	54.1	5	...	
101	50	...	40.8	...	...	
100	2	...	1.5	...	...	
111	30	...	13.8	3	...	
117	37	...	22.1	...	...	
118	12	...	16.1	...	...	
121	36	...	22.5	...	...	
124	8	...	12.7	...	...	
142	26	...	5.6	...	...	
151	40	324.7	...	16	11	
156	6	...	46.3	...	...	
160	6	...	96.6	...	...	
Totals	47.4	4,112.4	2,988.0	9,100	16,419	

*These figures represent the total number of cases reported as "Under Treatment" for

CTORS

Mea

of week

APPENDIX 1

HIGHWAY REGULATIONS APPLYING TO ALL ROADS IN THE VICINITY OF THE ASHOKAN RESERVOIR BUILT AND MAINTAINED BY THE CITY OF NEW YORK

In accordance with Chapter 478 of the Laws of 1914, the following regulations are hereby promulgated for the protection of all improved highways and bridges constructed by the Board of Water Supply in the vicinity of the Ashokan reservoir. These regulations shall take effect on July 1, 1914. Violations will be prosecuted to the full extent of the law.

CHARLES STRAUSS, President,
CHARLES N. CHADWICK,
JOHN F. GALVIN, } *Commissioners of the Board of Water Supply*

New York City, June 2, 1914.

SECTION 1. No traction-engine, trailer, road-roller, automobile truck or other vehicle, object or contrivance, operated or moved either by mechanical power or by animals, shall be operated or moved upon or over the said Ashokan highways, the faces or tires of any supporting or guiding wheels of which are not smooth or are fitted with flanges, lugs, spikes, or other projections, unless cleats not less than 2½ inches wide and of a greater thickness than the projections are fastened upon all such wheels, so placed that not less than two cleats on each wheel shall touch the ground at all times, and the weight be evenly distributed as provided in Section 3. Reapers and other farm machinery drawn by not more than two animals and not designed to be propelled by mechanical power are exempted from the above provision.

SECTION 2. No such vehicles or object shall be operated or moved upon or over the said Ashokan highways upon wheels, rollers or otherwise, in excess of a total weight of 14 tons, including the vehicle or object and load, without first obtaining a permit, as provided in Section 6. No weight in excess of eight tons shall be carried on any one axle.

SECTION 3. The width of tire, wheel, roller, or other means of support of any such vehicle or object shall be such that the total

weight, including load, shall not exceed 800 pounds upon any inch of said width, unless other permission be granted, as provided in Section 6.

SECTION 4. No such vehicle or object of a greater width than 90 inches, including load, shall be operated or moved upon said Ashokan highways, except traction-engines, which may have a width of 100 inches, without first obtaining a permit, as provided in Section 6.

SECTION 5. No such vehicle or object carrying a weight in excess of four tons, including the vehicle, shall be operated upon the said Ashokan highways at a speed greater than 15 miles an hour; and no such vehicle carrying a weight in excess of six tons, including the vehicle, shall be operated upon any such highway at a speed greater than six miles an hour when such vehicle or portion of vehicle is equipped with iron or steel tires, nor greater than 12 miles an hour when the vehicle is equipped with tires of hard rubber or other similar substance.

SECTION 6. The Board of Water Supply of The City of New York, upon proper application in writing, may grant permission for the moving of heavy or wide vehicles, loads, objects or contrivances over said highways under such restrictions as the said Board may prescribe.

SECTION 7. Any individual or corporation failing to observe these rules and regulations is guilty of a misdemeanor and in addition is liable for actual damages to the bridges and highways constructed by The City of New York, the said damages being recoverable by The City of New York.

INDEX

PAGE

PAGE